


# HULL BIOFOULING OF SUISUN BAY RESERVE FLEET VESSEL

# OCCIDENTAL VICTORY

# BEFORE AND AFTER TRANSIT FROM CALIFORNIA TO TEXAS

Prepared for

U. S. Maritime Administration
Office of the Environment
Washington, D.C.

Prepared by

Roberto J. Llansó
Kristine Sillett

Versar, Inc.
Ecological Sciences and Applications
9200 Rumsey Road
Columbia, Maryland 21045

January 2008

# ACKNOWLEDGEMENTS

We thank Versar's laboratory staff for sample processing, and those who contributed to the identification of species: Lisa Scott and Suzanne Arcuri (Versar), Tim Morris and Nancy Mountfort (Cove Corporation, Lusby, Maryland), Jeff Cordell (University of Washington), and Paul Valentich-Scott (Santa Barbara Museum of Natural History). We are grateful to Bryan Vogel (Maritime Administration, Western Region) and Chris Green (Green Environmental Services, Laguna Vista, Texas) for helping with field logistics, and to Carolyn Junemann for support and insight throughout the project. Underwater Services International (Gainesville, Florida) provided the divers and helped improve the sampling through their suggestions. Carol Delisle proofread a draft of the report.

# EXECUTIVE SUMMARY

As part of its obsolete vessel disposal program, the U. S. Maritime Administration (MARAD) oversees transfers of ships from reserve fleet locations to ship-breaking facilities. These vessels may pose a high risk of hull-mediated invasions because their underwater surfaces can be heavily fouled by aquatic organisms, and the vessels have a long residence time at their destination ports before they are dismantled. As a result, MARAD has considered implementing in-water hull cleaning as one management option to reduce the risk of transferring non-native species to new coastal regions where they may become established.

In this study, we examined the biota associated with the underwater surfaces of the OCCIDENTAL VICTORY before and after in-water cleaning of the hull in San Francisco Bay, and upon the ship's arrival in Brownsville, Texas. A World War II Victory Ship built in 1945, the OCCIDENTAL VICTORY had been inactive in the National Defense Reserve Fleet at Suisun Bay, California, for the past 20 years before being turned over to a ship-breaking company in June 2006. The company that acquired the OCCIDENTAL VICTORY is located on the Gulf Coast in Brownsville, Texas, which required that the ship be towed to Texas via the Panama Canal. The purpose for examining the fouling biota was to identify and quantify the species attached to or associated with the underwater surfaces of the ship, and examine their geographic distribution with respect to their possible transfer from San Francisco Bay to the Gulf of Mexico.

The OCCIDENTAL VICTORY was surveyed in Alameda, California, on September 29 and 30, 2006, prior to hull cleaning, on October 3 and 4 after hull cleaning, and on November 8 and 9 after transit from California. Samples were collected with the help of professional divers using a stratified random sampling protocol consisting of transects (anchor chain to stern) and sampling locations at three water depths (below water line, mid-depth, and bottom). In addition, samples were taken from the underwater appendages, including the stern tube, rudder, and propellers. A total of 150 samples were divided equally between the 3 surveys. Also, photos of the biota covering the hull were taken at each sampling location.

Across all surveys, 81 taxa (species or species groups) were recorded in the biological samples. Isopod crustaceans, the barnacle *Balanus improvisus*, and the bryozoan *Conopeum osburni* were the dominant organisms. In addition, all pre-cleaning samples had abundant turbellarians (flatworms). The most dominant organism in terms of biomass was *C. osburni*, which covered large areas of the hull in the pre-cleaning survey and provided habitat for other species, particularly amphipod and isopod crustaceans. Some samples had abundant bryozoan growth, while other samples had little bryozoan growth and more barnacle cover; however, there were no patterns in the percent cover of these two species across the hull.

Analysis of variance revealed significant differences in abundance and number of species between surveys. Likewise, multivariate analyses revealed differences in abundance and species composition between surveys, but no differences based on transect or location on the hull. In-water cleaning removed organisms from approximately 84% of the hull, as revealed by an analysis of the photo quadrats. The cleaning process clearly reduced much of the base layer of barnacles, the cover of bryozoans and hydroids, and the abundance of most species; nevertheless, many of the dominant species, such as amphipod and isopod crustaceans, and flatworms persisted after the cleaning of the hull. The loss of branching species, however, substantially reduced their numbers. With most of the barnacles and the thick layer of bryozoans gone, the amphipods, isopods, and flatworms were more vulnerable to the effects of turbulent flow during the voyage, and thus very few crustaceans and none of the flatworms were recovered in the post-transit samples.

Besides the obvious reduction in the abundance and occurrence of species in the post-cleaning survey compared to the pre-cleaning survey, we found that the post-transit survey had more species and greater abundance per sample than the post-cleaning survey in most transects. This difference was mostly due to new species collected only in Brownsville, suggesting that organisms may attach to the hull of vessels during the voyage.

Among the species found in the pre-cleaning survey, 16 were non-indigenous in California waters, 9 were cryptogenic (i.e., of uncertain origin), and 12 were native. The remaining taxa were higher level identifications with native species present in California, or undetermined species (pending identification). Species that were invasive in California but not recorded from Texas costal waters were not detected in the post-transit survey, suggesting that the risk of introducing potentially invasive species may be low.

Although our study demonstrates that in-water cleaning substantially reduces hull biofouling, viable organisms existed in association with the hull after the cleaning of the vessel and were transported to Texas. Before the magnitude of the risk can be formally assessed, more data are needed from additional ships and seasons, as well as additional assessments of the effectiveness of hull cleaning activities for a variety of ships.

# TABLE OF CONTENTS

# LIST OF FIGURES

# 1.0 INTRODUCTION

The OCCIDENTAL VICTORY, a World War II Victory Ship built in 1945, was added to the National Defense Reserve Fleet (NDRF) at Suisun Bay, California, in 1947 but remained inactive for the past 20 years. The NDRF at Suisun Bay, also referred to as the Suisun Bay Reserve Fleet (SBRF), is one of three fleets in the United States maintained by the U.S. Maritime Administration (MARAD). While some vessels in the NDRF are retained as part of the Ready Reserve Force, which can be activated during national emergencies, older obsolete vessels are removed and dismantled by ship-breaking companies that compete for disposal contracts.

Per MARAD's mandate to dispose of obsolete vessels from its NDRF, the OCCIDENTAL VICTORY was turned over to a ship-breaking company in June 2006. Ship-breaking companies sell the steel and other valuable materials after a vessel has been dismantled. The company that acquired the OCCIDENTAL VICTORY is located on the Gulf Coast in Brownsville, Texas, which required that the ship be towed to Texas via the Panama Canal.

The potential to transfer non-native species from ships originating in San Francisco to other locations such as the Gulf of Mexico is significantly greater than for ships moving within one geographic location. San Francisco Bay is recognized as the most invaded aquatic ecosystem in North America (Cohen and Carlton 1995). Non-native species are abundant and dominant throughout the benthic and fouling communities of San Francisco Bay. Introduced aquatic plants and animals have significantly affected the ecology of the region. In some areas exotic species outnumber native species, or it is difficult to find native species. Additionally, many species are considered cryptogenic, which are not clearly native or introduced.

The U.S. Department of Transportation has a statutory mandate to protect against aquatic invasive species. Executive Order 13112 calls for Executive Branch agencies to work to prevent the introduction and control the spread of invasive species, and to eliminate or minimize their associated economic, ecological, and human health effects. In-water hull cleaning of obsolete vessels is one management option considered by MARAD to reduce the risk of transferring non-native species to new coastal regions where they may become established as a result of their ship disposal program. Obsolete vessels are considered to have a higher risk of transferring species than active ships because they have been laid-up for long periods of time; the hulls have not been maintained and, therefore, are heavily fouled with aquatic organisms; and they have a long residence time at their destination ports before they are dismantled.

In this study, we examined the biota associated with the underwater surfaces of the OCCIDENTAL VICTORY before and after in-water cleaning of the hull in San Francisco Bay, and upon the ship's arrival in Brownsville, Texas. The vessel was moved from its original location at the SBRF at Benicia to Alameda, California, for biological sampling and hull cleaning prior to being towed to Texas. Hull fouling biota were collected to identify and quantify the species attached to or associated with the underwater surfaces of the OCCIDENTAL VICTORY, and to examine their geographic distributions with respect to their possible transfer from San Francisco Bay to the Gulf of Mexico. This study is similar in scope to the pilot assessments conducted on two other SBRF vessels, the POINT LOMA and FLORENCE (Davidson el al. 2006, 2007) and provides additional information about the composition and abundance of biological assemblages associated with obsolete vessels in Suisun Bay.

# 2.0 METHODS

## 2.1 WATER CHARACTERISTICS

Several water column parameters were measured on-site to characterize the environment that the biota encountered at the time of sampling. Parameters included temperature, salinity, conductivity, dissolved oxygen, and pH. Data were collected over the course of the biological surveys using a YSI 556 multiparameter probe with automatic temperature and salinity compensation (Yellow Springs Instruments, Inc., Yellow Springs, Ohio). Water parameter measurements were recorded at 3 foot (~1 meter) intervals from the water surface to the bottom of the hull at the bow and stern of the vessel. These data characterized local conditions at the time of sampling, but did not provide information about exposure at the berth location in Suisun Bay or during towing of the vessel to its final destination.

## 2.2 VESSEL SURVEY

The OCCIDENTAL VICTORY was surveyed over three separate dives, two in Alameda, California, and one in Brownsville, Texas, after transit from California. The vessel was towed from Suisun Bay to Alameda on September 28, 2006, and surveyed on September 29 and 30 prior to hull cleaning, and again on October 3 and 4 after cleaning. The vessel departed San Francisco Bay one day later and arrived in Brownsville on November 6, where the post-transit survey was conducted on November 8 and 9.

Samples were collected with the help of professional divers. Diving was conducted using surface-supplied air and real-time audio and visual communications with the surface team. The surface team included a diver master and two scientists who directed two of the divers toward the locations where samples and photo-quadrats were to be taken. Diving services were provided by Underwater Services International, Inc.

A stratified random sampling design similar to that previously employed to survey two other vessels in Suisun Bay (Davidson et al. 2006) was applied to the OCCIDENTAL VICTORY. Samples were taken at three depths (below water line, mid-depth, and bottom) along eight transects (Figure 2-1). The OCCIDENTAL VICTORY was 455 feet long, with a lightweight draft of 9.5 feet. Transects were positioned 55 feet apart from each other and ran across its hull. Five samples were collected per transect: starboard upper, starboard lower, bottom, port lower, and port upper. The first transect near the bow did not have a flat bottom; therefore, only four samples were collected from this transect. In addition to the hull sampling, 11 samples were taken from the underwater appendages of the vessel, including the stern tube, rudder, and propellers. Only one propeller blade was fully submerged. The OCCIDENTAL VICTORY did not have open sea chests. In Alameda, the port side of the vessel was tied up to another ship at the dock. Sampling was done from a barge positioned on the starboard side. The divers swam under the vessel to the port side and back to complete two sampling transects. In Brownsville, the vessel was moored directly to the dock, with the port side facing the dock. The divers swam under the vessel to the starboard side and back to complete two sampling transects.

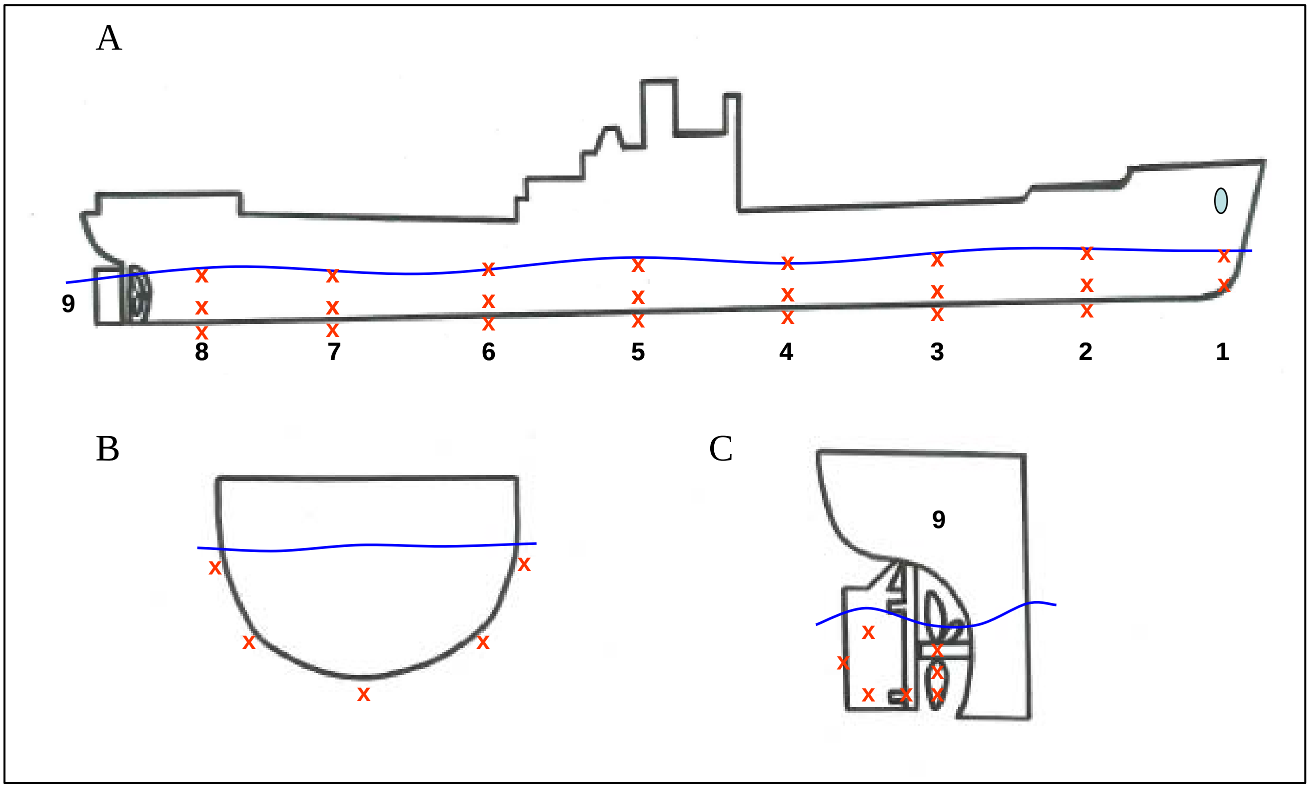



Figure 2-1. Sampling locations. Samples and photo-quadrats were taken at 8 transects across the hull of the OCCIDENTAL VICTORY (A). Five samples per transect were collected: starboard upper, starboard lower, bottom, port lower, and port upper (B). The first transect did not have a flat bottom; therefore, only four samples were collected from this transect. In addition, 11 samples were collected from the underwater appendages of the vessel (C): one from each side of the stern tube, three from the only fully submerged propeller, two from each side of the rudder, and one each from the leading edge and shoe bottom of the rudder. Underwater appendage locations were labeled as Transect 9.

At each sampling location, one diver positioned an underwater camera against the surface of the hull and photographed the biota covering the hull. The second diver then collected a sample from a random point within approximately a one-meter radius of the photo-quadrat location. A sampler constructed from a 6-inch (15.2 cm) diameter, T-shaped PVC pipe connector was used to collect the biota (Figure 2-2). A diver placed one end of the sampler (A in Figure 2-2) against the hull of the ship. The other end of the sampler (B in Figure 2-2) was sealed with neoprene; a slit in the neoprene barrier allowed the diver to insert a 3-inch scraper into the sampler and scrape biota from the hull. This sample was collected into a numbered cloth bag that was attached to the T-end of the sampler (C in Figure 2-2). The bag was twisted closed and tied off before being removed from the sampler to minimize sample loss. An area of approximately 182 $cm^2$ of hull was scraped for each sample. The bag number was relayed to the surface so that detailed notes could be taken on the location at which each sample was collected. Sample bags were stored in a mesh dive bag and returned to the surface, usually in groups of 10 bags corresponding to 2 sampling transects. Upon retrieval, all bags were immediately transferred to 5-gallon buckets with in situ marine water. Protexo bags manufactured by HUBCO (Hutchinson, Kansas) were used. Each bag was made of tightly woven, high thread count, white cotton cloth, and measured 10 x 17 inches (25.4 x 43.2 cm). Each bag included a drawstring that, in addition to a rubber band, kept the bag closed after sample collection. Fifty samples per sampling event (pre-cleaning, post-cleaning, and post-transit) were collected, for a total of 150 samples. Each sample was accompanied by a photo-quadrat. One sample was lost in the field; therefore, 149 samples were processed for species abundance and composition.

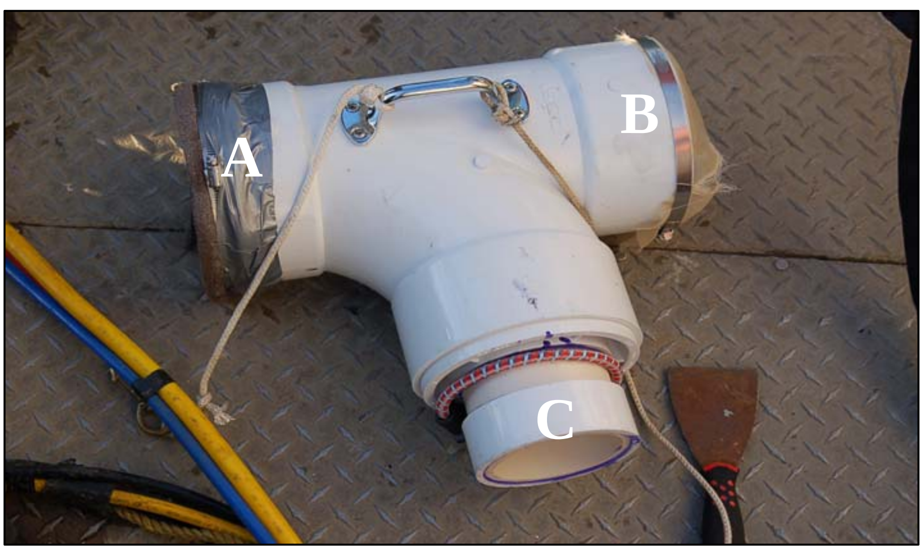



Figure 2-2. Sampler constructed from a 6-inch (15.2 cm) diameter, T-shaped PVC pipe connector. A diver places one end of the sampler (A) against the hull of the ship. The other end (B) allows the diver to insert a 3 inch scraper into the sampler and scrape biota material from the hull. The sample is collected into a cloth bag attached to the T-end of the sampler (C).

The system used for the photo-quadrats consisted of an underwater camera with a "clear-water box" attached to the front of the lens and two strobe lights mounted above the box at 45 degree angles. This system provided a standard image area for all photographs. In addition, the divers carried a video camera that provided real-time visual communication with the surface and video footage of the hull and the associated biota.

## 2.3 SAMPLE PROCESSING AND TAXONOMY

A visual examination of each sample was carried out on the dock. Bags were opened, inverted, and carefully washed through nested 250-$\mu$m and 64-$\mu$m sieves over a plastic dissecting tray (12 x 18 inches, 2.5 inch deep). The finer 64-$\mu$m fraction of the sample was transferred from the sieve into a Whirl-pack plastic bag, fixed in formalin, and stored for later examination in the lab.

The 250-$\mu$m fraction was poured into the plastic tray, examined, and photographed (Figure 2-3). Notes were taken as to the condition of the biota (potential live versus dead material), and the general kinds and quantity of organisms. This general procedure was conducted on as many samples as possible. Because of approaching night, some samples could not be photographed on dockside.

Figure 2-3. Samples were poured into plastic trays, examined, and photographed. This sample was taken from the upper port side of Transect 3 (fore) prior to hull cleaning. The tray measures 12 x 18 inches.

After examination, the contents of the tray were carefully poured back into the sample bag, and a label was added to the inside of the bag. Bags were then tightly closed with twist ties and rubber bands, and transferred to a magnesium chloride ($MgCl_2$) solution to relax the organisms for easier identification. The solution was made by dissolving $MgCl_2$ in tap water at a concentration of 75 g of $MgCl_2$ per liter of water (7.5% solution), and mixing equal parts of seawater and tap water. Because the solution is isotonic with seawater and the salinity at the dock sites was 30 (Alameda) or 34 psu (Brownsville), we did not adjust for salinity. After 30-60 min in the relaxant, bags were placed in 1-gallon plastic jars (3-5 bags per jar), and a buffered solution (10%) of formalin in seawater was added to fix the organisms. In the laboratory, samples were stored in formalin until further processing and identification of organisms.

In the laboratory, samples were washed through a 64-$\mu$m sieve and sorted under dissecting microscopes to separate organisms into major categories (e.g., bryozoans, barnacles, micro-crustaceans). Organisms in these major categories were counted (non-colonial species only) and identified to species by primary taxonomists whenever possible. Some organisms required further examination by specialist taxonomists for identification. Voucher specimens of these organisms were put in separate vials according to morphotypes (e.g., "Bryozoan 1", "Bryozoan 2") and sent to the specialists. Voucher specimens of species identified by the primary taxonomists were sent to the specialists for confirmation.

Due to time constraints, live and dead material were not separated in the field; however, the bulk component of each sample consisted of organisms that were alive at the time of collection. No obvious signs of dead material (e.g., exo-skeletons of crustaceans) were found in the samples upon examination in the field or in the laboratory, except for the empty tests of barnacles. These were counted as dead barnacles.

## 2.4 ANALYSIS

Samples were analyzed to look for differences in species numbers, composition, and abundance by transect and location (port upper, port lower, bottom, starboard upper, starboard lower, appendages) across the hull of the ship using univariate (Analysis of Variance) and multivariate methods. Ordination plots were constructed to examine sample configuration and to identify any tendency for samples to form groups according to their location along the hull. Species abundance data (counts) were log-transformed and subjected to non-metric multidimensional scaling (MDS) ordination on a Bray-Curtis similarity matrix using routines in the PRIMER (Plymouth Routines in Multivariate Ecological Research) v.6 statistical package (Clarke and Gorley 2006). The Group Average method was used to link samples in the analysis. Non-metric MDS constructs a plot in which samples are arranged in rank order according to their relative similarity. Samples that are similar in species composition and abundance are placed in close proximity to one another, whereas dissimilar samples are placed further apart. Data transformation was used prior to calculating similarities in order to balance the contribution of abundant species with high densities against those of less common species. Because abundance for colonial species (e.g., bryozoans) cannot be provided, the MDS analysis was repeated for presence/absence data using the full matrix of species and Sørensen's similarity index (Clarke and Gorley 2006, p. 48). The analysis was conducted on the pre-cleaning and post-cleaning samples to identify gradients in species abundance and composition, and on the post-transit samples to identify differences between surveys (post-cleaning and post-transit).

Photo-quadrats were examined by quantifying the percent cover of nine distinguishable categories in each image: bryozoan, barnacle, barnacle seat/organism remnant, crustacean, encrusting species, algae, biofilm, hull, and "other". Images were analyzed using the point count method to determine percentage cover of each category by superimposing a grid of 8 rows by 12 columns and populating each cell by 1 random point for a total of 96 random points (density: 3 points per squared inch of hull) (Figure 2-4). Because a ruler was added to the lower edge of the clear-water box during the post-transit sampling, post-transit images were analyzed using a 7 x 13 grid and 91 random points (density: 3.3 points per squared inch of hull). Points that were indistinguishable because the image was too dark were removed from the analysis. Thus the analysis provides percent cover of observable hull. Percent cover data were analyzed by MDS.

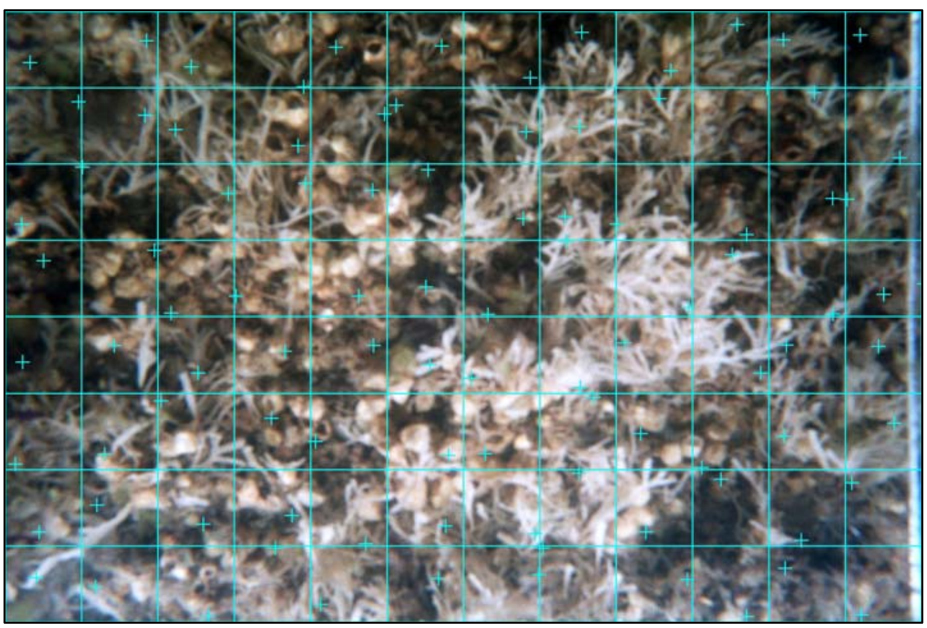


Figure 2-4. Grid of random points superimposed on an underwater photograph taken from the lower port side of Transect 6 (mid ship) prior to hull cleaning. Images were analyzed using the point count method to determine percentage cover of each of 9 categories. The area of the image provided by the camera was 203 $cm^2$ (4.5 x 7 inches).

# 3.0 RESULTS AND DISCUSSION

## 3.1 WATER CHARACTERISTICS

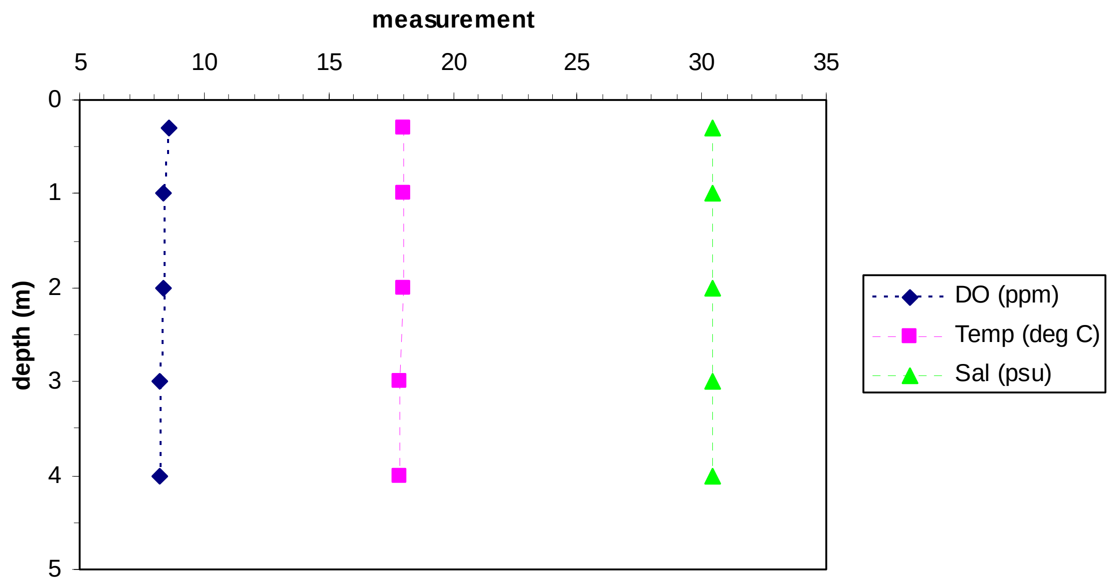
For all surveys, water characteristics varied little with depth. Temperature and salinity were higher, and dissolved oxygen was slightly lower in the port of Brownsville than in Alameda (Figure 3-1). Trends on different days were similar (data not shown). The salinity and temperature at these locations were quite different from the salinity and temperature to which the biota were exposed in Suisun Bay. Suisun Bay is dominated by seasonal freshwater flows causing salinity fluctuations that range from approximately 0 to 22 psu (Davidson et al. 2006). Salinity in San Francisco Bay and the port of Brownsville, however, is expected to be similar throughout the year due to the proximity of these locations to ocean waters. Temperature is also expected to fluctuate more widely in Suisun Bay due to the influence of variable freshwater flows and shallower depths. Regardless of the salinity and temperature differences, the biota present on the hull during the pre-cleaning and post-cleaning surveys should be similar to the biota present on the hull in Suisun Bay, because the voyage from Suisun Bay was short, and the vessel was sampled immediately upon arrival in Alameda.

The voyage between California and Texas is a different matter. The voyage took 27 days, during which the vessel was towed from San Francisco Bay to the Panama Canal in a southeasterly direction across 32 degrees of latitude, and then northwesterly to Brownsville across another 17 degrees of latitude. The range in salinity and temperature fluctuations experienced during the voyage is greater than the range expected in Suisun Bay (Davidson et al. 2007). During transit, biofouling organisms encounter salinities ranging between 0 (Panama Canal) and 37 psu, and temperatures ranging between 10ºC and 32ºC (Davidson et al. 2007), and the rate of change as the vessel goes through the Panama Canal is large. In addition to this stress, biofouling organisms are subjected to physical disturbance from waves, swells, and the shear forces generated by the vessel's propulsion. Low tow speeds, however, can enhance the settlement of organisms on the hull of ships (see Section 3.3 below).

## 3.2 SPECIES COMPOSITION

The 149 samples collected from the OCCIDENTAL VICTORY yielded a total of 81 taxa, of which 35 were identified to species level, and 15 to genus level. The remaining taxa could be identified only to higher levels of resolution. Some taxa were juveniles and difficult to distinguish. Table 3-1 lists the taxa; gives their frequency of occurrence in the pre-cleaning, post-cleaning, and post-transit surveys; and presents their biogeographic status in California waters. Appendix A shows their abundance in each of the samples, and Appendix B presents invasion status, distribution, habitat, and life history information.

A.




B.

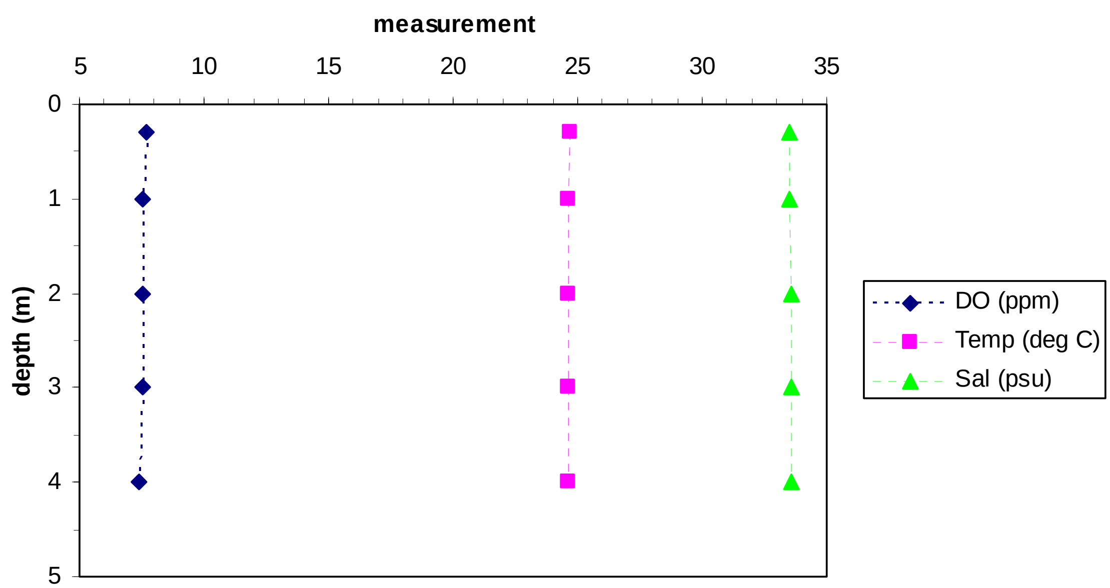



Figure 3-1. Dissolved oxygen, temperature, and salinity during (A) the pre-cleaning survey of the OCCIDENTAL VICTORY in Alameda, CA, on September 29, 2006, 3:50 pm, and (B) the post-transit survey in Brownsville, TX, on November 8, 2006, 11:45 am. Measurements were taken at 3 foot (~1 m) intervals to the maximum depth of draft using a YSI 556 multiparameter probe.

Taxonomic resolution of some of these taxa is pending and will be included in future reports. Because the sorting of the smaller, 64-μm fraction of the sample required a large amount of effort beyond the scope of this study, only a subset of these samples from the pre-cleaning survey was examined by subsampling. The post-cleaning and post-transit 64-μm samples had very few organisms, and all of these organisms are included in the data presented in this report. The pre-cleaning 64-μm fraction was dominated by copepods. Copepods were identified to genus level and included in Table 3-1.

Table 3-1. Species recorded in biological samples. The frequency of occurrence (percent of samples) in pre-cleaning, post-cleaning, and post-transit surveys; the biogeographic status of species in California waters; and whether the species was present in the POINT LOMA or FLORENCE vessels (Davidson et al. 2006, 2007) is shown. Because not all the 64-μm samples were examined, frequency of occurrence for copepod species and ostracods is not provided. Status: I = invasive (non-native species); C = cryptogenic; N = native; NP = native species present; ? = undetermined (species not yet identified). *No record/not present in California.

| Group | Species | % Samples | | | Status | Present in Point Loma/ Florence |
|---|---|---|---|---|---|---|
| | | Pre-cleaning | Post-cleaning | Post-transit | | |
| Copepoda | *Acartia tonsa* | - | - | - | N | x |
| Algae | Algae sp. A | 24 | 2 | 0 | ? | Algae |
| Algae | Algae sp. B | 0 | 0 | 18 | ? | Algae |
| Amphipoda | *Allorchestes* sp. | 0 | 2 | 0 | N | |
| Amphipoda | *Americorophium spinicorne* | 80 | 8 | 0 | N | x |
| Copepoda | *Amphiascoides* sp. | - | - | - | NP | |
| Amphipoda | *Ampithoe valida* | 12 | 4 | 0 | I | |
| Branchiura | *Argulus* sp. | 2 | 0 | 0 | NP | |
| Cirripedia | *Balanus amphitrite* | 0 | 0 | 4 | I | x |
| Cirripedia | *Balanus improvisus* | 100 | 46 | 48 | C | x |
| Cirripedia | barnacle cypris | 2 | 0 | 0 | NP | |
| Bivalvia | Bivalvia sp. A | 0 | 0 | 40 | ? | Bivalves |
| Polychaeta | *Boccardiella ligerica* | 82 | 4 | 0 | I | Boccardiella sp. |
| Ectoprocta | *Bugula neritina* | 2 | 0 | 0 | C | Bugula sp. |
| Ectoprocta | *Bugula stolonifera* | 8 | 0 | 0 | I | Bugula sp. |
| Amphipoda | *Caprella equilibra* | 16 | 0 | 0 | N | |
| Amphipoda | *Caprella mutica* | 2 | 2 | 0 | I | |
| Amphipoda | *Caprella* sp. | 10 | 4 | 0 | NP | x |
| Amphipoda | Caprellidae (juv.) | 6 | 2 | 0 | NP | |
| Decapoda | Caridea spp. | 0 | 0 | 10 | NP | x |
| Chaetognatha | Chaetognatha | 0 | 0 | 44 | NP | |
| Ectoprocta | Cheilostomate encrusting bryozoan | 4 | 0 | 0 | NP | x |
| Insecta | Chironomidae (juv.) | 2 | 0 | 0 | NP | x |
| Hydrozoa | *Clytia* sp. | 0 | 0 | 4 | C | x |
| Tunicata | Colonial tunicate (Botryliidae?) | 2 | 0 | 0 | NP | x |
| Ectoprocta | *Conopeum osburni* | 100 | 100 | 100 | C | x |
| Copepoda | Copepods | 100 | 0 | 60 | NP | x |
| Bivalvia | *Corbula* sp. | 53 | 2 | 0 | NP | x |
| Amphipoda | Corophidae sp. (juv.) | 31 | 10 | 4 | NP | |
| Decapoda | crab megalop | 0 | 0 | 8 | NP | |
| Isopoda | Cymothoidae | 0 | 0 | 8 | NP | |

| Table 3-1. (Continued) | | | | | | |
|---|---|---|---|---|---|---|
| | | % Samples | | | | Present in Point Loma/ Florence |
| Group | Species | Pre-cleaning | Post-cleaning | Post-transit | Status | |
| Decapoda | Decapoda (juv.) | 0 | 0 | 2 | NP | |
| Copepoda | *Diarthrodes* sp. | - | - | - | NP | |
| Polychaeta | *Eteone californica* | 4 | 0 | 0 | C | |
| | fish eggs | 2 | 0 | 2 | NP | |
| Amphipoda | *Gammarus daiberi* | 16 | 0 | 0 | I | x |
| Hydrozoa | *Garveia franciscana* | 51 | 22 | 42 | I | x |
| Gastropoda | Gastropoda | 2 | 0 | 2 | NP | x |
| Isopoda | *Gnorimosphaeroma oregonensis/insulare* | 80 | 26 | 8 | N | x |
| Decapoda | Grapsidae | 0 | 0 | 2 | NP | x |
| Copepoda | *Halicyclops* sp. | - | - | - | NP | |
| Hydrozoa | Hydroid sp. A | 0 | 0 | 2 | ? | Hydroids |
| Polychaeta | *Hydroides elegans* | 2 | 0 | 0 | I | |
| Amphipoda | *Incisocalliope derzhavini* | 63 | 0 | 0 | I | |
| Amphipoda | *Jassa carltoni*? | 6 | 0 | 0 | N | |
| Amphipoda | *Jassa slatteryi* | 4 | 0 | 0 | C | |
| Amphipoda | *Jassa* sp. (juv.) | 4 | 6 | 0 | NP | x |
| Amphipoda | *Jassa staudei* | 16 | 4 | 0 | N | |
| Amphipoda | *Laticorophium baconi* | 0 | 0 | 2 | C | x |
| Cirripedia | *Lepas anatifera* | 0 | 0 | 4 | N | L. pacifica |
| Decapoda | *Lucifer faxoni* | 0 | 0 | 12 | * | |
| Amphipoda | *Melita nitida* | 31 | 8 | 0 | I | x |
| Copepoda | *Mesochra* sp. | - | - | - | NP | |
| Amphipoda | *Monocorophium acherusicum* | 69 | 16 | 0 | I | x |
| Amphipoda | *Monocorophium insidiosum* | 2 | 2 | 0 | I | |
| Amphipoda | *Monocorophium* sp. (juv.) | 12 | 12 | 0 | I | |
| Mysidae | Mysidae | 0 | 0 | 6 | NP | x |
| Bivalvia | Mytilidae (juv.) | 2 | 0 | 0 | NP | |
| Polychaeta | *Neanthes succinea* | 6 | 0 | 0 | I | x |
| Nemertina | Nemertina | 10 | 0 | 0 | NP | |
| Copepoda | *Nitokra* sp. | - | - | - | NP | |
| Gastropoda | Nudibranchia (juv.) | 20 | 0 | 0 | NP | x |
| Copepoda | *Oithona* sp. | - | - | - | NP | |
| Oligochaeta | Oligochaeta | 24 | 0 | 0 | NP | x |
| Ostracoda | Ostracoda | - | - | - | NP | |
| Polychaeta | *Polydora cornuta* | 43 | 6 | 0 | C | Polydora sp. |
| Copepoda | *Schizopera* sp. | - | - | - | NP | |
| Polychaeta | Serpulidae sp. (juv.) | 0 | 0 | 4 | NP | x |
| Tanaidacea | *Sinelobus stanfordi* | 14 | 0 | 0 | I | |
| Polychaeta | Spionidae sp. (juv.) | 2 | 8 | 26 | NP | |
| Amphipoda | *Stenothoe* sp. | 27 | 16 | 0 | NP | S. valida |
| Amphipoda | Stenothoidae sp. (juv.) | 6 | 0 | 0 | NP | |
| Turbellaria | *Stylochus franciscanus* | 100 | 16 | 0 | N | |
| Polychaeta | Syllidae spp. (juv.) | 4 | 4 | 0 | NP | |
| Isopoda | *Synidotea laticauda* | 100 | 42 | 0 | I | |
| Tanaidacea | Tanaidae spp. (juv.) | 2 | 0 | 4 | NP | |
| Turbellaria | Turbellaria sp. A | 88 | 8 | 0 | ? | Flat worms |
| Polychaeta | *Typosyllis alternata* | 8 | 0 | 0 | C | Typosyllis sp. |
| | Unidentified sponge-like organism | 10 | 0 | 36 | ? | |
| Isopoda | *Uromunna ubiquita* | 100 | 24 | 2 | N | x |
| Tanaidacea | *Zeuxo paranormani* | 14 | 2 | 0 | N | |

Samples were dominated by the barnacle *Balanus improvisus*, the bryozoan *Conopeum osburni*, and isopod crustaceans. In addition to these organisms, all pre-cleaning samples showed abundant flatworms (Turbellaria, Table 3-1). The most dominant organism in terms of biomass was *C. osburni*, which covered large areas of the hull in the pre-cleaning survey and provided habitat for other species, particularly amphipod and isopod crustaceans. This finding concurs with those of the surveys of the POINT LOMA and FLORENCE (Davidson et al. 2006). Some samples had abundant bryozoan growth (Figure 3-2), and other samples had little bryozoan growth and more barnacle cover (Figure 3-3); however, there were no patterns in the percent cover of these two species across the hull (see Section 3.4).

There were marked differences in species composition between the OCCIDENTAL VICTORY (this report) and the POINT LOMA and FLORENCE surveys (Davidson et al. 2006). Some species that occurred frequently, were abundant, or both on the OCCIDENTAL VICTORY, were either present in low frequency on the other two vessels (*Boccardiella ligerica* and *Corbula* sp.) or were not recorded on those vessels (*Incisocalliope derzhavini*, *Monocorophium acherusicum*, *Synidotea laticauda*, turbellarians, and tanaids). Conversely, the amphipod *Gammarus daiberi* was found on most of the POINT LOMA and FLORENCE samples but occurred infrequently on the OCCIDENTAL VICTORY. We were unable to attribute any of these differences to discrepancies in taxonomy. Although the use of a PVC sampler may have contributed to the higher number of species reported in our survey, we would have expected to find those species that are abundant on the hull of all vessels. The differences may be due to season. The POINT LOMA and FLORENCE were surveyed in early February, whereas the OCCIDENTAL VICTORY was surveyed in late September. Differences may also be due to intrinsic variability in the populations of 'boom and bust' species, that is, species that mature rapidly and have high reproductive potential. The real cause, however, is unknown. The implication is that the composition and abundance of biofouling organisms may vary among vessels or between surveys conducted in different seasons or in different years. These differences might be important if a particular non-indigenous species with invasive capabilities were to colonize the hull of obsolete vessels in a specific season or year and have a higher risk of being introduced to Gulf of Mexico waters if the transferal of a vessel coincided with a peak in the abundance of the species.

Of the taxa that could be classified according to their status in California (35 species-level and 3 genus-level identifications), 16 were introduced to California, 9 were cryptogenic (i.e., of uncertain origin), 12 were native, and 1 did not occur in California (Table 3-1). Of the remaining taxa, 37 were higher level identifications with native species present in California, and 6 were undetermined (pending identification).

We also classified taxa according to their status in Texas (Appendix B). Of those that could be classified (35 species-level and 2 genus-level identifications), 8 taxa were introduced to Texas, 2 were cryptogenic, 10 were native, and 17 (to our knowledge) were not recorded in Texas. The potential for introduction to Texas, therefore, existed for 17

Figure 3-2. A sample collected from the bottom of the ship along Transect 5 prior to in-water hull cleaning that had abundant bryozoan growth.

Figure 3-3. A sample collected from the bow of the ship along Transect 1 prior to in-water hull cleaning that had more barnacle cover and little bryozoan growth.

species, 5 of which were invasive in California (*Caprella mutica*, *Gammarus daiberi*, *Incisocalliope derzhavini*, *Sinelobus stanfordi*, and *Synidotea laticauda*). None of these five species, however, were found in the post-transit survey of the OCCIDENTAL VICTORY (Table 3-1).

## 3.3 DIFFERENCES BETWEEN SURVEYS, TRANSECTS, AND LOCATIONS

There were significant differences in the number of species per sample between surveys (Figure 3-4 A, B) and there was a significant interaction between survey and transect (2-way ANOVA; sampling event, $F = 33.3$, $p < 0.001$; transect, $F = 1.82$, $p = 0.08$; interaction, $F = 2.68$, $p < 0.01$), but there were no significant differences among locations across the hull of the ship (2-way ANOVA; sampling event, $F = 52.6$, $p < 0.001$; location, $F = 0.25$, $p = 0.91$; interaction, $F = 0.75$, $p = 0.65$). A 3-way ANOVA (with three factors: sampling event, transect, and location) could not be performed because the bottom location was not replicated within transect. The interaction term indicated that the post-cleaning and post-transit surveys differed significantly in number of species, but that the difference depended on transect. The post-transit survey had more species per sample than the post-cleaning survey in transects 1 to 7, but fewer species per sample in transects 8 and 9 (Figure 3-4 A).

There were significant differences in abundance (total counts per sample) between surveys (Figure 3-5 A, B), but interactions were significant, indicating that these differences depended on transect (2-way ANOVA; sampling event, $F = 5.87$, $p < 0.01$; transect, $F = 0.006$, $p = 1.0$; interaction, $F = 4.71$, $p < 0.001$) and location across the hull of the ship (2-way ANOVA; sampling event, $F = 7.56$, $p < 0.001$; location, $F = 0.006$, $p = 0.99$; interaction, $F = 3.05$, $p < 0.01$). As with number of species, the post-transit survey had greater abundance per sample than the post-cleaning survey in transects 1 to 7, but lower abundance per sample in transects 8 and 9 (Figure 3-5 A).

Multivariate analysis of species abundance and composition data (colonial species excluded) revealed no differences among pre-cleaning samples based on transect (Figure 3-6) or position on the hull (Figure 3-7), except for a group of upper port samples with high abundance of organisms. Also, analysis of presence-absence data (all species included) revealed no differences among pre-cleaning samples based on transect (Figure 3-8) or position on the hull (Figure 3-9). Likewise, there were no differences among either the post-cleaning or post-transit samples based on transect or position on the hull (MDS plots not shown). However, the post-cleaning and post-transit samples overlapped little in the MDS plot (Figure 3-10), indicating that species assemblages (based on abundance and composition) were different after the ship's transit from California.

The pre-cleaning, post-cleaning, and post-transit samples formed distinct groups in the analysis of presence-absence data (Figure 3-11), indicating clear differences in species composition among surveys. Differences between post-cleaning and post-transit samples persisted after removing from the analysis species that were considered pelagic (Figure 3-12), a few of which showed up in the samples collected in Brownsville. Differences between the post-cleaning and post-transit samples were due to species that were collected only in Brownsville (i.e., a species of algae, a new bivalve, the barnacles *Balanus amphitrite* and *Lepas anatifera*, two species of hydroids, the amphipod *Laticorophium baconi*, the shrimp *Lucifer faxoni*, serpulid polychaetes), species with higher frequency of occurrence in post-transit samples (i.e., the hydroid *Garveia franciscana*, spionid polychaetes, sponge-like organisms), and species that were present in post-cleaning samples but were not found upon arrival of the ship in Brownsville (i.e., turbellarians and most amphipods). Figure 3-13 provides an example of the distribution of the Bivalve sp. A among the post-cleaning and post-transit samples.

The cleaning process clearly reduced much of the base layer of barnacles, the cover of *C. osburni* and *G. franciscana*, and the abundance of most species; nevertheless many of the dominant species, such as amphipods, isopods, and flatworms, persisted after the cleaning of the hull. The loss of branching species, however, substantially reduced their numbers. Bryozoans and hydroids provide 3-dimensional structure to the community, which allows other species to find food and refuge and proliferate within the mat. When the barnacles and the thick layer of *Conopeum* and *Garveia* are removed, the amphipods, isopods, and flatworms become more vulnerable to the effects of turbulent flow during the voyage. Thus very few amphipods and isopods and none of the flatworms were recovered in post-transit samples, the organisms that survived the cleaning presumably were dislodged in transit between San Francisco Bay and Brownsville.

During transit, and at low towing speeds, settlement of organisms may be enhanced as the flow brings planktonic larvae in contact with the underwater surfaces of the ship. Thus some of the organisms that were found only in the post-transit survey may have settled during the voyage. This appeared to be the case for the Bivalve sp. A, the barnacle *B. amphitrite*, and the pelagic gooseneck barnacle *L. anatifera*, whose individuals on the hull of the OCCIDENTAL VICTORY were exceedingly small. Note, however, that the abundance of these organisms in the post-transit samples decreased toward the stern of the vessel (transects 8 and 9), suggesting a greater effect of turbulent flow in this region of the ship, as would be expected from studies of ship hydrodynamics.

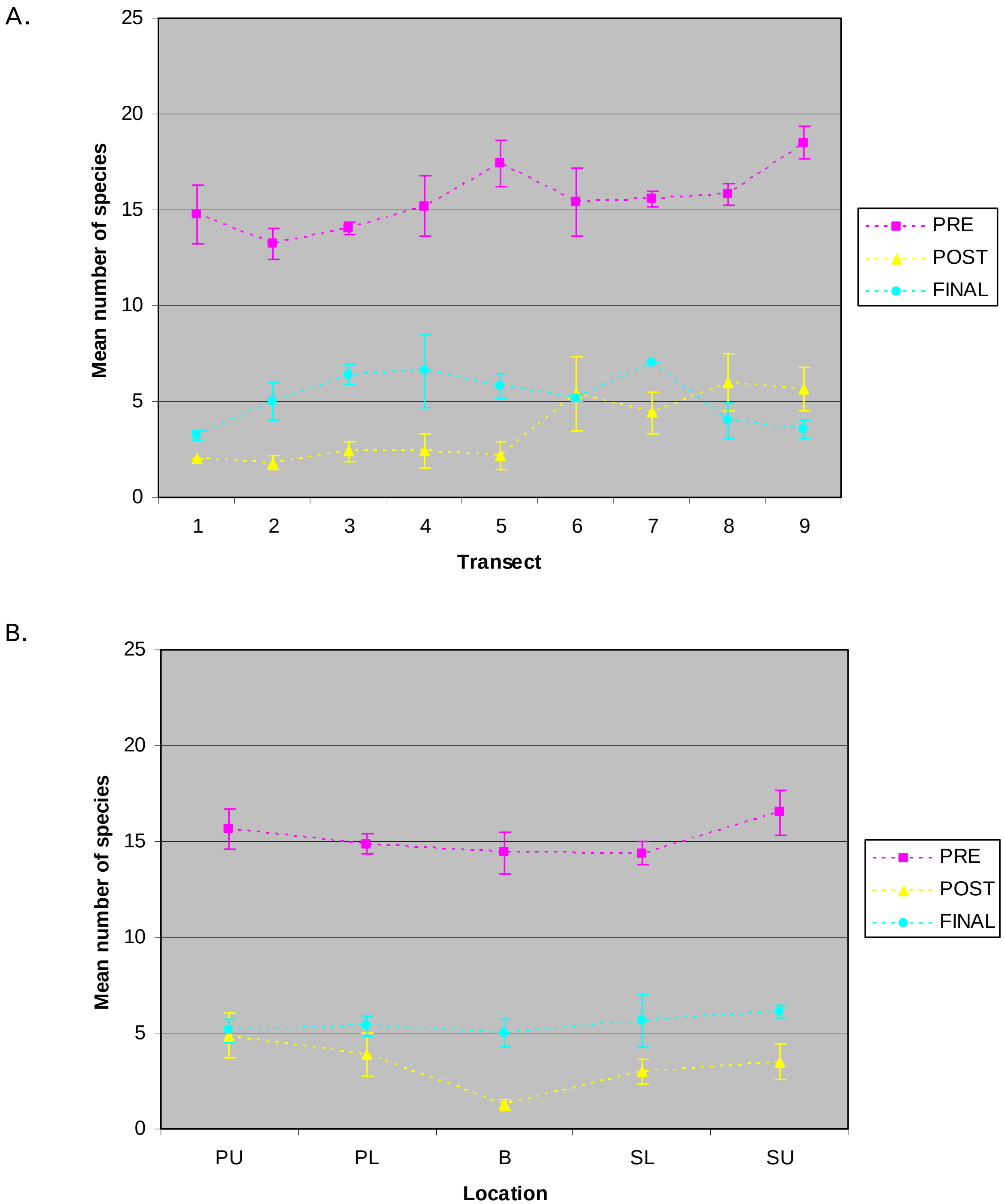
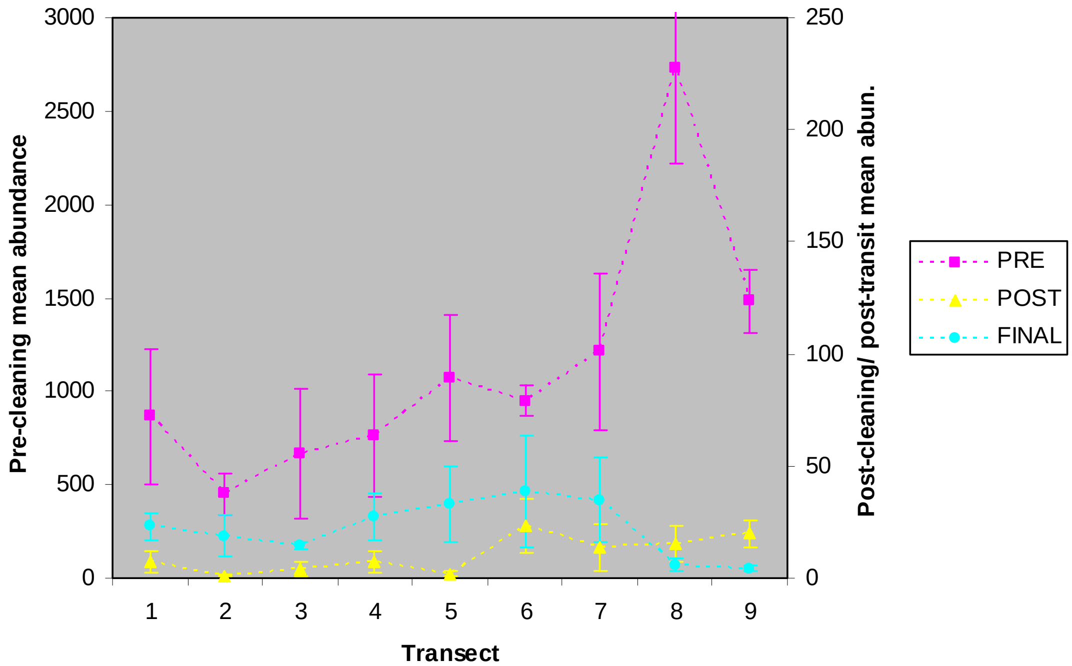



Figure 3-4. Mean number of species (±1 SE) on the hull of the OCCIDENTAL VICTORY by transect (A) and position across the hull (B), prior to hull cleaning (PRE), after hull cleaning (POST), and after transit from California (FINAL). Transect 1 = anchor chain, Transect 9 = stern appendages. PU = port upper, PL = port lower, B = bottom, SL = starboard lower, SU = starboard upper.

A.




B.

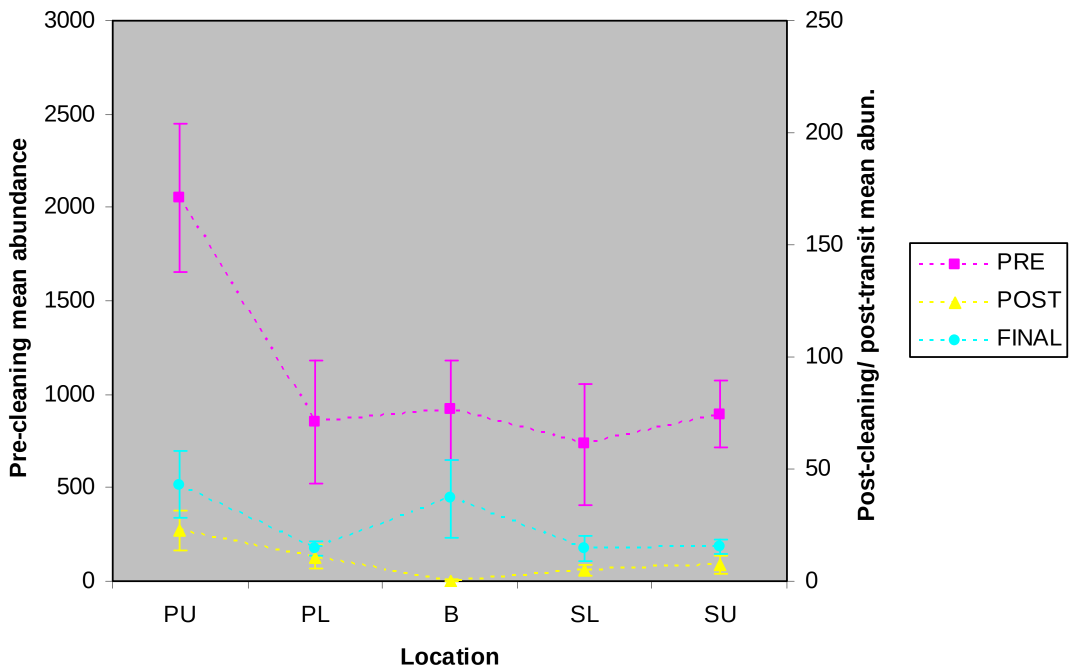



Figure 3-5. Mean total species abundance (±1 SE) on the hull of the OCCIDENTAL VICTORY by transect (A) and position across the hull (B), prior to hull cleaning (PRE), after hull cleaning (POST), and after transit from California (FINAL). Transect 1 = anchor chain, Transect 9 = stern appendages. PU = port upper, PL = port lower, B = bottom, SL = starboard lower, SU = starboard upper.

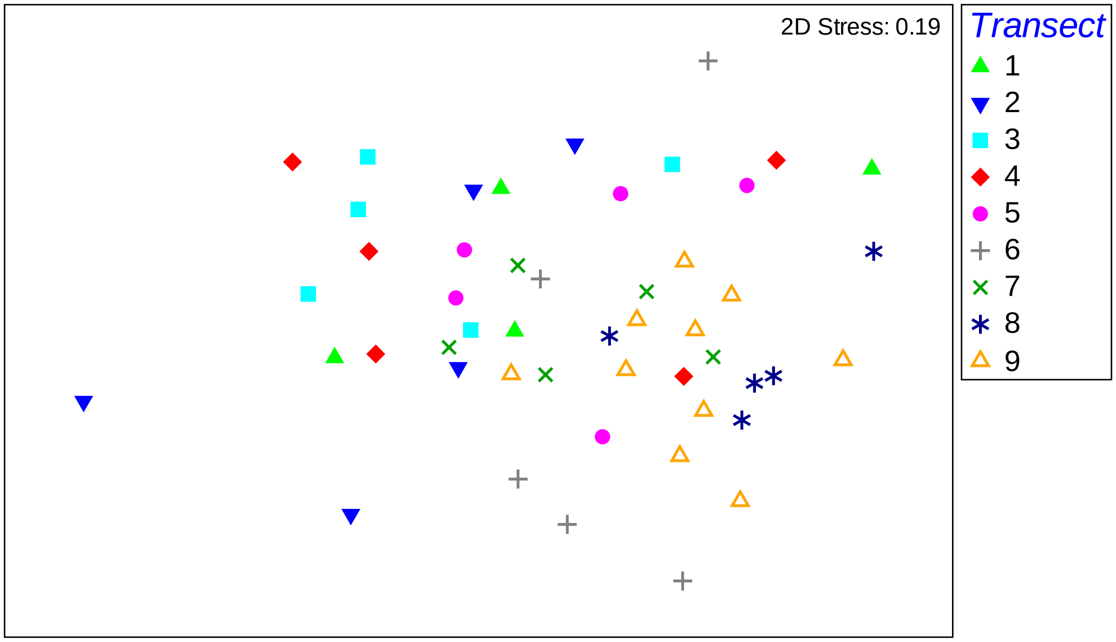



Figure 3-6. MDS for species abundance and composition of samples taken prior to hull cleaning. There is no separation of samples based on transect.

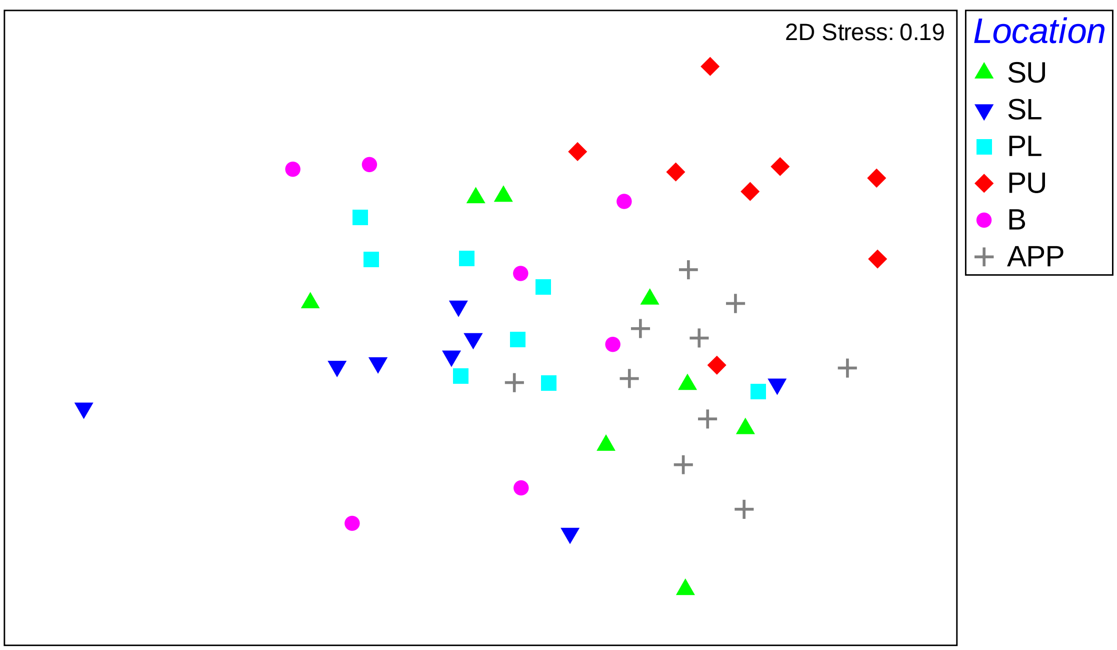



Figure 3-7. MDS for species abundance and composition of samples taken prior to hull cleaning. There is no separation of samples based on their position in the hull, except for a group in the upper right corner of the diagram consisting of upper port samples. SU = starboard upper, SL = starboard lower, PL = port lower, PU = port upper, B = bottom, APP = appendages.

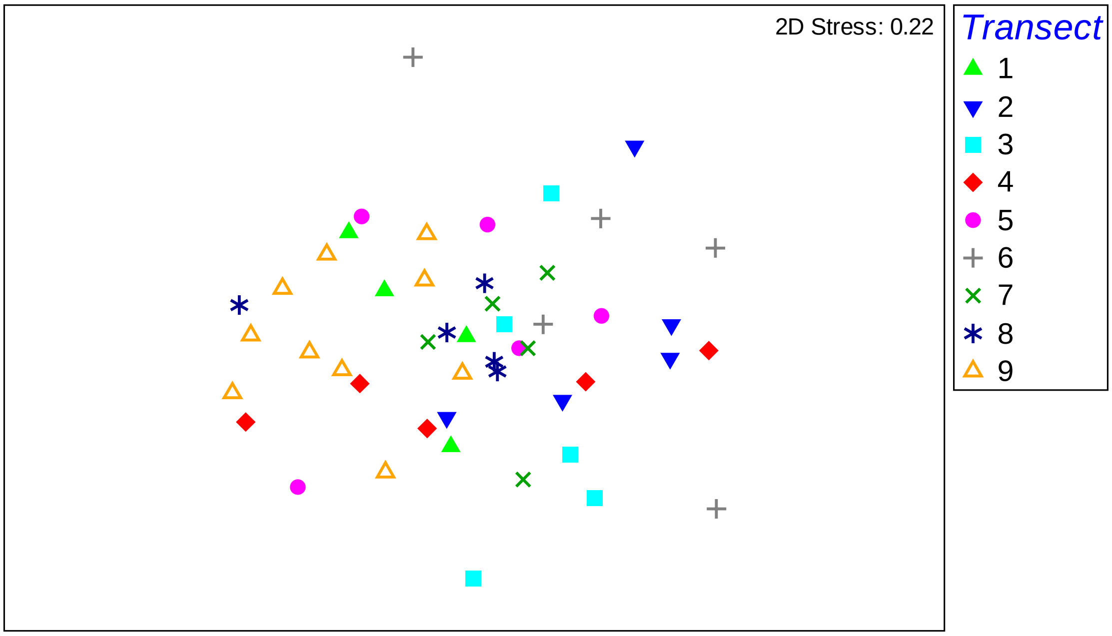



Figure 3-8. MDS for presence-absence of species of samples taken prior to hull cleaning. As with the plot based on species abundance and composition, there is no separation of samples classified by transect.

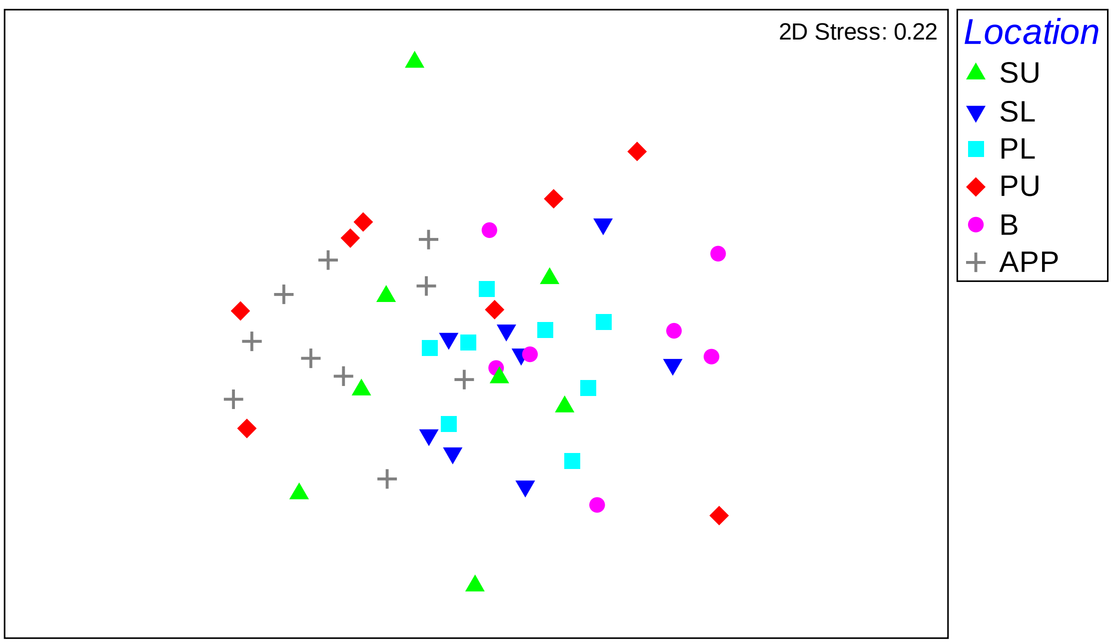



Figure 3-9. MDS for presence-absence of species of samples taken prior to hull cleaning. There is no separation of samples classified by position in the hull. Unlike with the species abundance and composition plot, upper port (PU) samples are dispersed in this diagram. SU = starboard upper, SL = starboard lower, PL = port lower, PU = port upper, B = bottom, APP = appendages.

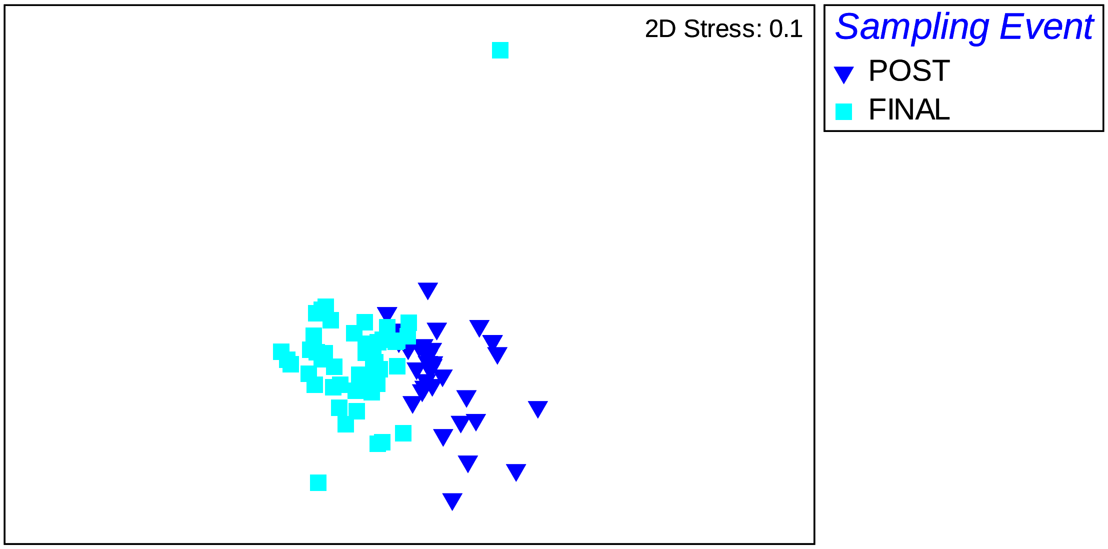



Figure 3-10. MDS for species abundance and composition of post-cleaning (POST) and post-transit (FINAL) samples. There is little overlap between the two groups of samples, indicating that there were differences in species assemblages (based on abundance and composition) on the hull of the vessel after transit from California.

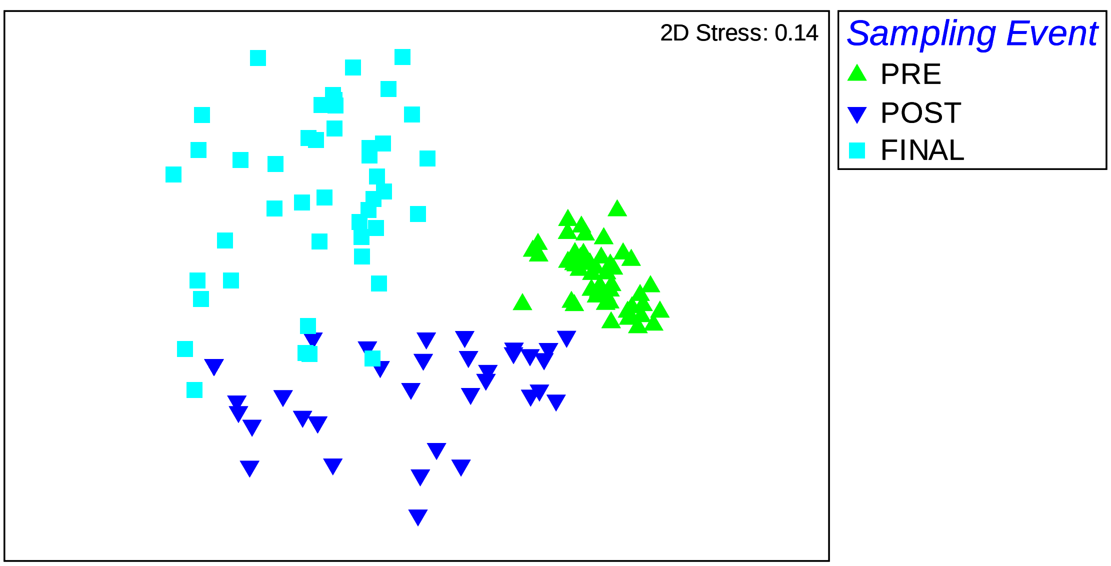



Figure 3-11. MDS for presence-absence of species. Pre-cleaning (PRE), post-cleaning (POST), and post-transit (FINAL) samples form distinct groups in the diagram, indicating that there were differences in species assemblages (based on presence-absence data) among surveys.

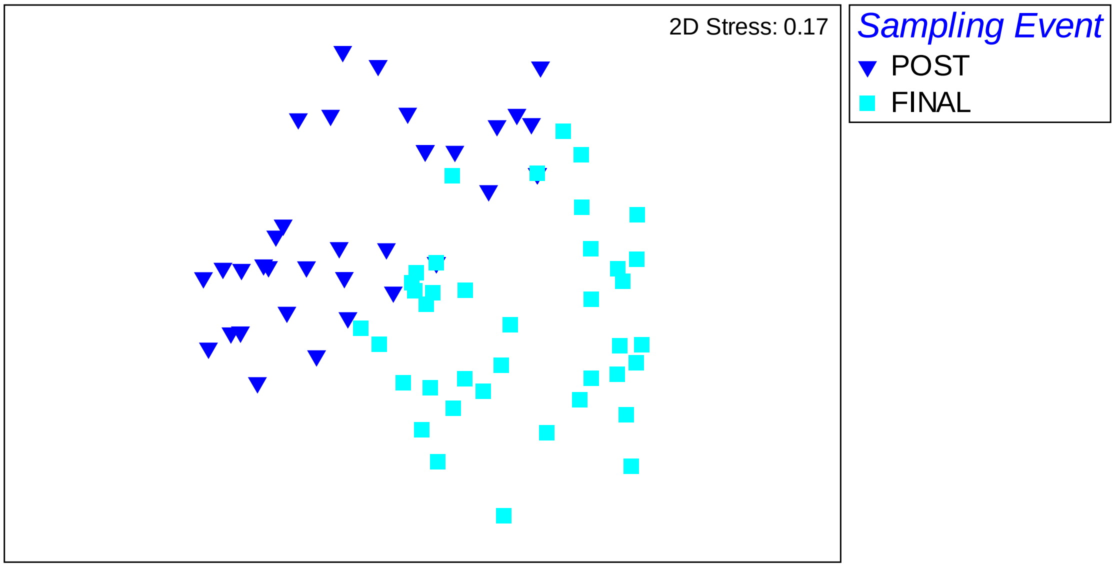



Figure 3-12. MDS for presence-absence of species. Differences between post-cleaning (POST) and post-transit (FINAL) samples persisted after removing species that were considered pelagic (unlikely associated with the hull of the vessel).

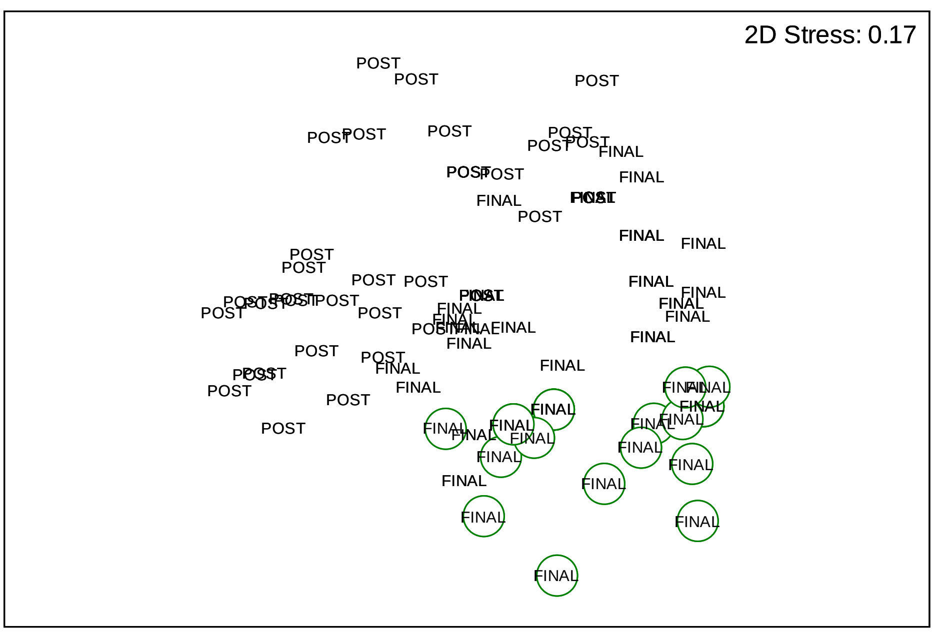



Figure 3-13. MDS for presence-absence of species, with Bivalvia sp. A superimposed on the plot. This is the same plot as in Figure 3-12 above, but using labels instead of symbols. Bivalvia sp. A (circles) was present only in post-transit samples (FINAL). This was one of the species that contributed to the observed differences between the post-cleaning and post-transit surveys.

## 3.4 ANALYSIS OF PERCENT COVER

The photo-quadrat analysis revealed no differences in percent cover of organisms among transects or locations on the ship, with the sole exception of low cover in transect 1 (near the bow) of *C. osburni* (range 2-39%, average 13%) in the pre-cleaning survey. Associated with the low cover of this branching bryozoan was a high cover of barnacles (range 61-98%, average 87%). In fact, where percent cover of *C. osburni* decreased, percent cover of barnacles increased, possibly because the bryozoan mat concealed a base layer of barnacles that could not otherwise be observed in the photos. The spread of points in the MDS plot (Figure 3-14) reflects the wide range of percent cover of barnacles (range 0-98%, average 43%) and *C. osburni* (range 1-100%, average 53%) in the photo-quadrats of the pre-cleaning survey. Few other categories were identifiable in the photos of the pre-cleaning survey (algae: range 0-12%, average 1.2%; encrusting species: range 0-32%, average 2.2%). No bare hull was observed.

In contrast with the pre-cleaning survey, bare hull (range 59-100%, average 84%) and barnacle seats (range 0-39%, average 15%) predominated in the post-cleaning survey, and bare hull (range 13-100%, average 78%), barnacle seats (range 0-65%, average 16%), and algae (range 0-76%, average 4%) predominated in the post-transit survey. The spread of points from the diagonal in the MDS plot (Figure 3-15) reflects the presence of algae in photo-quadrats of the post-transit survey, and abundant barnacles and *C. osburni* in a few of the photo quadrats of the post-cleaning and post-transit surveys. Percent cover of barnacles ranged from 1% to 8% in 22 photo-quadrats in the post-cleaning survey, and from 1% to 17% in 19 photo-quadrats in the post-transit survey. Percent cover of *C. osburni* ranged from 1% to 5% in 7 photo-quadrats in the post-cleaning survey, and from 1% to 32% in 5 photo-quadrats in the post-transit survey. Thus cover of *C. osburni* was substantially reduced after the cleaning of the hull; nevertheless, all samples (Table 3-1) contained at least small fragments of this species.

The viability of fragments of colonial organisms is an important question in considering the risk of transferring potentially invasive species. We observed numerous fragments of both *C. osburni* and *G. franciscana* in post-transit samples. Some of the fragments may have resulted from scraping intact colonies during post-transit sampling in Brownsville. We observed considerable growth of bryozoans on some areas of the hull in video images during the post-transit survey. Many fragments, however, may have remained attached to the hull after cleaning and been carried from California to Brownsville. Asexual reproduction is common among hydrozoans and can be achieved by fragmentation. Fragments of some species drift with the currents and contribute to dispersal and establishment of new colonies (Gravier-Bonnet and Bourmaud 2005). We do not know if *G. franciscana* is able to grow from fragments, but the species may grow from the bases of stolons (the dense network of tubes attached to the surface of the substrate). Cheilostome bryozoans also have been found to disperse by fragmentation (Thomsen and Hakansson 1995). Therefore, the risk of transferring colonial organisms such as bryozoans


Figure 3-14. MDS of photo-quadrat data. There were no differences in percent cover of organisms among transects or locations on the ship, with the sole exception of low cover near the bow of *Conopeum osburni*. The spread of points in this plot reflects the wide range in percent cover of barnacles and *C. osburni* in the photo-quadrats of the pre-cleaning survey.

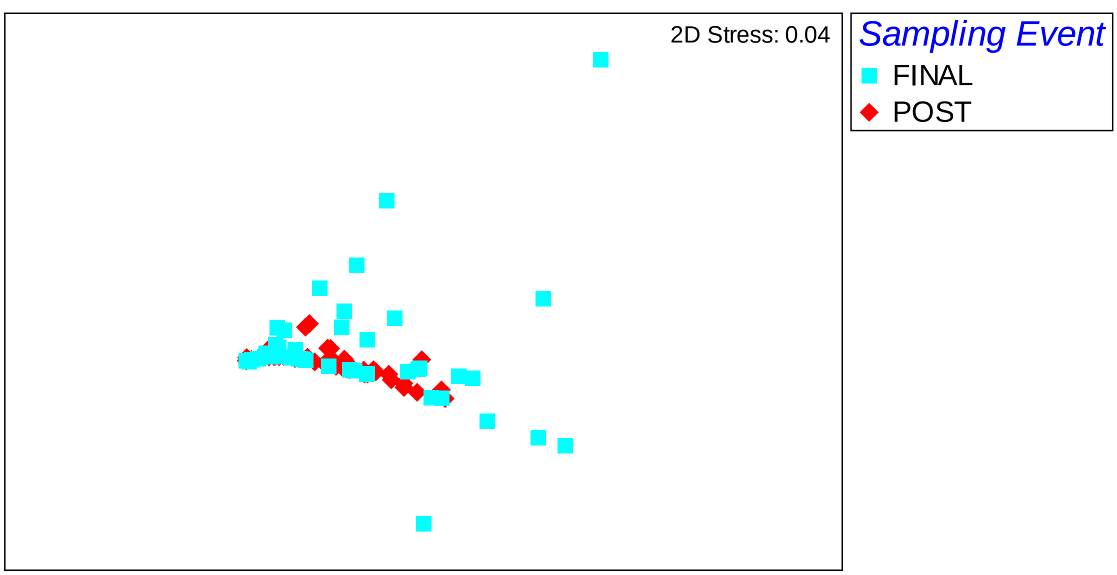



Figure 3-15. MDS of photo-quadrat data. The spread of points from the diagonal in the plot reflects the presence of algae in photo-quadrats of the post-transit survey, and of abundant barnacles and *Conopeum osburni* in a few photo quadrats of the post-cleaning and post-transit surveys.

and hydroids may be considerable. *C. osburni* has not been recorded outside of California, but the genus includes species that have been reported as being invasive around the world. *G. franciscana* has already been reported in the western Gulf of Mexico.

## 3.5 RISK OF SPECIES INTRODUCTIONS

The pre-cleaning survey of the OCCIDENTAL VICTORY in Alameda found 17 species that are unknown to occur in the coastal waters of Texas. Five of these species are non-indigenous in California, and three are cryptogenic. Except for *C. osburni*, none of these species were found in the post-transit survey. Although the species may have been present on the hull but remained undetected in the post-transit survey, in general the results of the survey suggest that the risk of species introductions may be low. The cleaning of the hull was successful at removing 84% of the biofouling cover. A formal risk assessment, however, will be needed to determine the magnitude of the risk. This risk assessment should include data from additional ships, the risk of species attachments during the voyage to Texas, and available information on the viability and reproductive capability of organisms at destination regions. This report provides relative densities of organisms per sample, which is one element needed in the risk analysis.

In comparing our results to those of the POINT LOMA and FLORENCE (Davidson et al. 2006, 2007), we observed differences in species composition among ships. Because the ships were sampled at different times of the year, the results suggest that temporal variability may be an important factor in determining hull biofouling abundance and composition and, hence, risk of species introductions. For example, we found only a few *Corbula* (most likely the invasive species *C. amurensis*) in the pre-cleaning survey, but their numbers may be higher during peaks of abundance of this species in the benthos, which usually coincide with periods of high river flow in the Sacramento and San Joaquin rivers. Since its introduction in San Francisco Bay, *C. amurensis* has overwhelmed the natural communities and changed many aspects of their ecosystem. Differences among ships may also reflect length of berthing at the Reserve Fleet, because thick mats of colonial organisms that develop over time in older ships tend to harbor a greater number of species.

# 4.0 SUMMARY AND CONCLUSIONS

1. Pre-cleaning, post-cleaning, and post-transit surveys of biofouling were conducted on the Suisun Bay National Defense Reserve Fleet vessel OCCIDENTAL VICTORY. The surveys yielded a total of 81 taxa, 35 of which could be identified to species level, and 15 to genus level. Among the species found in the pre-cleaning survey conducted in San Francisco Bay, 16 (20% of all taxa) were non-indigenous in California waters.

2. Species composition and abundance differed among the three surveys. Post-cleaning and post-transit surveys differed significantly in species number and abundance, and the difference depended on transect. There were no significant differences due to position (below water line, mid-depth, and bottom) within transect.

3. The biofouling community prior to hull cleaning was dominated by the barnacle *Balanus improvisus* and the bryozoan *Conopeum osburni*, and by isopod crustaceans. Barnacles, bryozoans, and hydroids formed a thick mat over most of the hull, but not uniformly. In the analysis of underwater photos, approximately 43% of the hull was covered by barnacles but not by bryozoans. Percent cover of organisms was not different among transects and locations on the hull, except for a larger proportion of barnacle cover near the bow. Bryozoan growth provided habitat for other species, particularly numerous amphipod and isopod crustaceans. Organisms were not concentrated in sheltered areas of the hull, such as the rudder or other appendages.

4. In-water cleaning removed organisms from approximately 84% of the hull, substantially reducing the thick cover of bryozoans and hydroids. However, hull cleaning did not make surfaces less susceptible to settlement by fouling organisms. New species that were not recorded in the pre-cleaning or post-cleaning surveys were found upon the arrival of the vessel in Brownsville, Texas, suggesting that organisms may attach to the hull during the voyage.

5. Obsolete vessels in the Suisun Bay National Defense Reserve Fleet are potential pathways for species introductions to regions where the ships are dismantled. Viable organisms existed in association with the hull after the cleaning of the vessel, and were transported to Texas. However, species that were invasive in California but not recorded from Texas costal waters were not detected in the post-transit survey, suggesting that the risk of introducing potentially invasive species may be low.

6. We found differences in species composition between the OCCIDENTAL VICTORY and the surveys of two previous ships, suggesting that length of berthing at the Reserve Fleet and seasonal variability in biofouling may be important factors in determining community composition and, hence, risk of species transport and introductions.

7. Before the magnitude of the risk can be formally assessed, more data are needed from additional ships and seasons, as well as additional assessments of the effectiveness of hull cleaning activities in a variety of ships, and information on viability and reproductive capability of organisms at destination regions.

# 5.0 REFERENCES

Ashton, G.V. 2006. Distribution and dispersal of the non-native caprellid amphipod, Caprella mutica Schurin 1935. Thesis presented for the degree of Doctor of Philosophy at the University of Aberdeen.

Bushek, D. and S. Boyd. 2006. Seasonal abundance and occurrence of the Asian isopod Synidotea laevidorsalis in Delaware Bay, USA. Biological Invasions 8:697-702.

CA Fish & Game. 2002. A Survey of Non-Indigenous Aquatic Species in the Coastal and Estuarine Waters of California. California Department of Fish & Game, Office of Spill Prevention and Response, Sacramento, California.

Carlton, J.T. 1979. Introduced Invertebrates in San Francisco Bay. Pp. 427-444 In: San Francisco Bay: The Urbanized Estuary; Investigations into the Natural History of San Francisco Bay and Delta with Reference to the Influence of Man. Pacific Division of the American Association for the Advancement of Science, San Francisco, California.

Chapman, J.W. and J.T. Carlton. 1994. Predicted discoveries of the introduced isopod, Synidotea laevidorsalis (Miers, 1881). Journal of Crustacean Biology 14:700-714.

Clarke, K.R. and R.N. Gorley. 2006. PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth Marine Laboratory, Plymouth, United Kingdom.

Cohen, A.N. and J.T. Carlton. 1995. Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta. Report submitted to the U. S. Fish and Wildlife Service, Washington D.C. and the National Sea Grant College Program, Connecticut Sea Grant (NOAA Grant Number NA36RG0467).

Cohen, A.N. and 11 authors. 2002. Project Report for the Southern California Exotics Expedition 2000: A Rapid Assessment Survey of Exotic Species in Sheltered Coastal Waters. California Department of Fish and Game, State Water Resource Control Board, and National Fish and Wildlife Foundation.

Conlan, K.E. 1990. Revision of the crustacean amphipod genus Jassa Leach (Corophioidea: Ischyroceridae). Canadian Journal of Zoology 68:2031-2075.

Davidson, I., G. Ruiz, M. Sytsma and P. Fofonoff. 2006. Hull Biofouling on the Vessels POINT LOMA and FLORENCE in the Reserve Fleet at Suisun Bay, CA: A Pilot Study with Respect to Potential Transfer of Non-native Species. Report submitted to the U. S. Maritime Administration, Washington D.C.

Davidson, I., G. Ruiz, M. Sytsma, P. Fofonoff, B. Mohammad, L. McCann, C. Zabin, and S. Altman. 2007. A Post-Voyage Analysis of Hull Biofouling on the Vessels POINT LOMA and FLORENCE After Transit from California to Texas. Report submitted to the U. S. Maritime Administration, Washington D.C.

Gravier-Bonnet, N. and C. Bourmaud. 2005. Cloning by releasing specialized frustules in a successful epiphytic zooxanthellate haleciid (Cnidaria, Hydrozoa, Haleciidae), with comments on stolonization and frustulation. Invertebrate Reproduction and Development 48:63-69.

Hendrycks, E.A. and E.L. Bousfield. 2001. The amphipod Allorchestes in the North Pacific region: systematics and distributional ecology: Amphipacifica 3:3-38.

Hyman, L.H. 1953. The Polyclad flatworms of the Pacific Coast of North America. Bulletin of the American Museum of Natural History 100:269-391.

Kilgen, R.H and R.J. Dugas. 1989. The Ecology of Oyster Reefs of the Northern Gulf of Mexico: An Open File Report. NWRC-Open File Rep. 89-02.

LeCroy, S. 2004. An Illustrated Identification Guide to the Nearshore Marine and Estuarine Gammaridean Amphipoda of Florida. Volume 3. Florida Department Environmental Protection, Tallahassee, Florida.

Maloney, E., R. Fairey, A. Lyman, K. Reynolds and M. Sigala. 2006. Introduced Aquatic Species in California Open Coastal Waters. Final Report submitted to California Department of Fish & Game, Office of Spill Prevention and Response, Sacramento, California.

McCain, J.C. 1968. The Caprellidae (Crustacea: Amphipoda) of the Western North Atlantic. United States National Museum Bulletin 278, Smithsonian Institution Press, Washington, D.C.

Sieg, J. and R.N. Winn. 1981. The Tanaidae (Crustacea: Tanaidacea) of California, with a key to the World genera. Proceedings of the Biological Society of Washington 94:315-343.

Soule, D.F., J.D. Soule and H.W. Chaney. 1995. Taxonomic Atlas of the Benthic Fauna of the Santa Maria Basin and Western Santa Barbara Channel. Volume 13 - The Bryozoa. Santa Barbara Museum of Natural History, Santa Barbara, California.

Thomsen, E. and E. Håkansson. 1995. Sexual versus asexual dispersal in clonal animals: examples from cheilostome bryozoans. Paleobiology 21:496-508.

Williams, A.B. 1984. Shrimps, Lobsters, and Crabs of the Atlantic Coast. Smithsonian Institution Press, Washington, D.C.

# APPENDIX A

## SPECIES ABUNDANCE

Sample code: 1 = pre-cleaning, 2 = post-cleaning, 3 = post-transit; P = present; blank = species not found in the sample.

| Species | 1-01 | 1-02 | 1-03 | 1-04 | 1-05 | 1-06 | 1-07 | 1-08 | 1-09 | 1-10 | 1-11 | 1-12 | 1-13 | 1-14 | 1-15 | 1-16 | 1-17 | 1-18 | 1-19 | 1-20 | 1-22 | 1-23 | 1-24 | 1-25 | 1-26 | 1-27 | 1-28 | 1-29 | 1-30 | 1-31 | 1-32 | 1-33 | 1-34 | 1-35 | 1-36 | 1-37 | 1-38 | 1-39 | 1-40 | 1-41 | 1-42 | 1-43 | 1-44 | 1-45 | 1-46 | 1-47 | 1-49 | 1-50 | 1-51 | 2-01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Algae sp. A | P | | | P | | | | | | | | | | | | P | | P | | | | P | | P | | | | | P | | | | | | P | | | | | P | P | | | | | | P | | P | |
| Algae sp. B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Allorchestes sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Americorophium spinicorne | 1 | 5 | 2 | 1 | 5 | 8 | | 3 | 8 | 2 | 5 | | | | 1 | 1 | | 11 | 27 | 4 | 4 | 5 | 3 | 5 | | 1 | 15 | 6 | 22 | | 14 | 10 | 24 | 20 | | 20 | 12 | 44 | 64 | 11 | 9 | 48 | 33 | 90 | 16 | 21 | | | 41 | |
| Ampithoe valida | | | | 14 | | | | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | | 1 | | | | | 4 | | 1 | 1 | | | | | | | |
| Argulus sp. | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Balanus amphitrite | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Balanus improvisus | 256 | 192 | 552 | 341 | 269 | 197 | 107 | 61 | 387 | 129 | 132 | 51 | 47 | 171 | 155 | 140 | 42 | 114 | 407 | 252 | 88 | 81 | 65 | 141 | 255 | 100 | 134 | 168 | 452 | 389 | 112 | 144 | 234 | 380 | 472 | 1260 | 379 | 952 | 326 | 311 | 523 | 761 | 425 | 907 | 244 | 629 | 886 | 708 | 446 | 5 |
| Balanus improvisus (dead) | 45 | 51 | 54 | 68 | 54 | 81 | | | 29 | 78 | 43 | 40 | 40 | 71 | 28 | 61 | 39 | 102 | 80 | 92 | 33 | 47 | 53 | 7 | | 63 | 76 | | | 102 | 88 | 45 | 120 | 180 | 225 | 252 | 144 | 288 | 183 | 145 | 335 | 64 | 122 | 94 | 62 | | 167 | 201 | 79 | |
| barnacle cypris | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bivalvia sp. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Boccardiella ligerica | | 10 | 28 | 2 | | 11 | 8 | 3 | | 2 | 7 | 1 | 4 | 2 | | 3 | | 4 | 15 | 9 | 3 | 9 | 4 | | | 2 | | 13 | | 3 | 5 | 1 | 11 | 24 | 8 | 16 | 13 | 16 | 72 | 5 | 3 | 62 | | 64 | 7 | 5 | 31 | 13 | 13 | |
| Bugula neritina | | | | | | | | | | | | | | | | | | | | | | | | | | | | | P | | | | | | | | | | | | | | | | | | | | | |
| Bugula stolonifera | | | | | | P | | | | | | | | | | | | | | | | P | | | | | | | P | P | | | | | | | | | | | | | | | | | | | | |
| Caprella equilibra | 1 | | | | 2 | 1 | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 3 | | | 1 | | | | 1 | | | |
| Caprella mutica | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caprella sp. | | | | | | 4 | | | | | | | | | | 1 | | | | 1 | 1 | | | | | | | | 1 | | | | | | | | | | | 2 | | 1 | | | | | | | | |
| Caprellidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | | | | | | | | | | | | | | | | | 1 | | |
| Caridea | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaetognatha | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cheilostomate encrusting bryozoa | | | | | | | | | | | P | | | | | | | | | | | | | | | | P | | | | | | | | | | | | | | | | | | | | | | | |
| Chironomidae | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clytia sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colonial tunicate (Botryliidae?) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | |
| Conopeum osburni | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P |
| copepods | P | P | P | P | 2 | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | 1 | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | 1 | P | P | P | P | P | P | P | |
| Corbula sp. | 1 | 1 | 2 | 1 | | 1 | | | | | | | | 4 | 6 | | | 1 | 22 | 2 | | | | 1 | | | | 2 | 1 | 3 | | | 1 | | 15 | 8 | | 8 | | 7 | 3 | 7 | | 6 | | 1 | 2 | 2 | 2 | |
| Corophiidae sp. (juv.) | 1 | | | | | | 5 | 2 | | | | | 1 | | | | | | | 40 | | | | | 9 | | 14 | 47 | | 56 | 1 | 2 | | 8 | | 308 | | | 12 | | | 16 | | | | | | | | |
| crab megalop | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cymothoidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Decapoda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Eteone californica | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | |
| fish eggs | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | |
| Gammarus daiberi | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | 1 | | | | | | | 2 | | | | | | 5 | 8 | | | 1 | | | | | 1 | | | | |
| Garveia franciscana | | | | P | | | P | P | | P | P | P | P | P | | P | P | P | | | P | P | P | P | | P | P | P | P | P | | P | P | | | | | | | | | | | | P | P | | | P | |
| Gastropoda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | |
| Gnorimosphaeroma oregonensis/insulare | 20 | 1 | 5 | 183 | 54 | 6 | 3 | | 26 | | 2 | | | 37 | 97 | | | | 20 | 24 | 1 | 2 | | 87 | 76 | 1 | | 2 | 21 | 30 | | 1 | 1 | 48 | 242 | 68 | 6 | 36 | 10 | 149 | 99 | 9 | 4 | 40 | 6 | 18 | 21 | 22 | 15 | |
| Grapsidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroid sp. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroides elegans | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| Incisocalliope derzhavini | 1 | | 1 | 27 | | | | | | | 8 | | 4 | | 14 | | | | 9 | 1 | 3 | 50 | 7 | 58 | | 15 | | | 15 | | 13 | 2 | 2 | 12 | 24 | 12 | 8 | 72 | 88 | 10 | 11 | | 4 | | 2 | 15 | 5 | 13 | 5 | |
| Jassa carltoni? | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | 4 | | | | | | | | 1 | | |
| Jassa slatteryi | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| Jassa sp. (juv.) | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 1 | | | | | |
| Jassa staudei | | 1 | | | | 1 | | | | 1 | | | | | 1 | | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | 8 | | 1 | | | | | | |
| Laticorophium baconi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepas anatifera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lucifer faxoni | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Melita nitida | 2 | | | 12 | | | | | | | 1 | | | | 1 | | | | | | | | | 2 | | | | | | | | | 1 | | 4 | | | | | 1 | | 3 | | 3 | 2 | 5 | 3 | 1 | 4 | |
| Monocorophium acherusicum | | 2 | 2 | 1 | | 2 | | | 1 | 3 | 1 | | | | | 1 | | | 4 | 9 | 6 | 2 | 3 | 5 | 2 | | 9 | 3 | 15 | | 4 | 1 | 5 | 12 | | | 13 | 54 | 48 | 7 | 1 | 6 | 5 | 5 | 4 | 8 | | 6 | 5 | |
| Monocorophium insidiosum | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monocorophium sp. (juv.) | | 1 | 1 | | | | | | 1 | | 6 | 2 | | | | | 1 | 5 | 4 | 1 | 3 | 3 | 3 | 3 | 4 | 4 | 6 | | 19 | 4 | 3 | | 8 | 8 | | 12 | | 20 | 28 | 6 | 2 | 11 | 2 | 12 | 6 | 7 | | 2 | 5 | |
| Mysidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mytilidae (juv.) | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Neanthes succinea | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 4 | | 4 | | | | | | | | | | | | | | |
| Nemertina | | | | | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | 2 | | 1 | | 1 | | | | |
| Nudibranchia | | | | | 1 | | | | | | | | | 1 | | | 1 | | | | | 12 | 1 | | | 1 | 12 | 1 | | | | | | | | 4 | | | | | 1 | | | | | | | | | |
| Oligochaeta | | | | 1 | | | | | | | | | | 4 | | | | | 5 | | | | | | | | 4 | | 1 | | | | | 4 | | | | | | 8 | 1 | 1 | | 3 | | | | 1 | 4 | |
| Polydora cornuta | | | | 3 | 2 | | | | 1 | | | 1 | | 5 | 5 | 1 | | | 1 | | | 6 | 5 | 1 | 3 | | | | | | | 1 | 1 | | 8 | | 2 | 4 | 54 | | | | 1 | 1 | | | 3 | | | |
| Serpulidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sinelobus stanfordi | | | | 349 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 15 | | | | | 9 | 2 | 1 | | | | | | 4 | | |
| Spionidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| sponge-like | | | | | 1 | | 22 | 2 | | | | | | | | | | | | | | | | | | | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Stenothoe sp. | | | | | | | | | | | | | | | 1 | | | 2 | 2 | | | 2 | | 2 | | | | | | | | | | | 2 | | | | | 13 | 1 | 9 | 1 | 1 | | | 1 | 5 | | |
| Stenothoidae sp. (juv.) | | | | | | | | | | 4 | | | 1 | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stylochus franciscanus | 3 | 3 | 10 | 37 | 5 | 2 | 9 | 2 | 8 | 5 | 8 | 2 | 5 | 10 | 28 | 6 | 5 | 6 | 15 | 6 | 3 | 6 | 5 | 5 | 20 | 14 | 12 | 14 | 16 | 22 | 5 | 10 | 3 | 24 | 23 | 12 | 6 | 16 | 9 | 14 | 30 | 16 | 33 | 22 | 4 | 14 | 8 | 17 | 5 | |
| Syllidae sp. (juv.) | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| Synidotea laticauda | 44 | 23 | 35 | 101 | 184 | 33 | 44 | 7 | 21 | 18 | 14 | 87 | 70 | 622 | 464 | 31 | 61 | 21 | 122 | 73 | 122 | 694 | 269 | 531 | 427 | 180 | 333 | 238 | 24 | 215 | 35 | 458 | 54 | 692 | 1079 | 264 | 183 | 320 | 229 | 668 | 525 | 122 | 159 | 149 | 134 | 241 | 118 | 69 | 227 | |
| Tanaidae sp. (juv.) | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Turbellaria sp. A | 4 | | 2 | | 2 | 4 | 4 | 1 | 4 | | 1 | 4 | 2 | 3 | 1 | 3 | 4 | 3 | 7 | | 1 | 3 | 5 | | | 11 | 9 | 5 | 10 | 1 | 2 | 3 | 6 | 4 | 5 | 8 | 5 | 24 | 19 | 7 | 9 | 6 | 14 | 8 | 3 | 4 | 5 | 7 | 1 | |
| Typosyllis alternata | | | | | | | | | | 1 | | | | | | | | | 1 | 1 | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | | | | |
| Uromunna ubiquita | 82 | 12 | 102 | 765 | 191 | 88 | 202 | 24 | 34 | 76 | 138 | 172 | 63 | 1105 | 1054 | 44 | 33 | 20 | 422 | 200 | 121 | 1221 | 83 | 734 | 307 | 311 | 257 | 663 | 287 | 442 | 87 | 235 | 240 | 1364 | 2242 | 852 | 736 | 996 | 656 | 802 | 837 | 200 | 752 | 209 | 21 | 270 | 269 | 358 | 166 | |
| Zeuxo paranormani | | | | | | | | | | 1 | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | 5 | 1 | 6 | 1 | | | | 1 | | | |
| TOTAL | 461 | 302 | 796 | 1906 | 775 | 441 | 404 | 105 | 521 | 320 | 366 | 365 | 238 | 2035 | 1859 | 292 | 186 | 290 | 1166 | 727 | 389 | 2144 | 509 | 1583 | 1103 | 703 | 882 | 1164 | 891 | 1269 | 373 | 916 | 713 | 2784 | 4368 | 3100 | 1512 | 2858 | 1799 | 2193 | 2394 | 1362 | 1558 | 1616 | 513 | 1240 | 1521 | 1431 | 1018 | 5 |

| Species | 2-03 | 2-04 | 2-05 | 2-06 | 2-07 | 2-08 | 2-09 | 2-10 | 2-11 | 2-12 | 2-13 | 2-14 | 2-15 | 2-16 | 2-17 | 2-19 | 2-20 | 2-21 | 2-22 | 2-23 | 2-24 | 2-25 | 2-26 | 2-27 | 2-28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Algae sp. A | | | | | | | | | | | | | | | | | | | | | | | | | |
| Algae sp. B | | | | | | | | | | | | | | | | | | | | | | | | | |
| Allorchestes sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Americorophium spinicorne | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| Ampithoe valida | | | | | | | | | | | | | | | | | 1 | | | | | | | | |
| Argulus sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Balanus amphitrite | | | | | | | | | | | | | | | | | | | | | | | | | |
| Balanus improvisus | 21 | | | 1 | | 3 | | | | | | 10 | 4 | | | | | | | | | 14 | 6 | | |
| Balanus improvisus (dead) | | | | | | | | | | | | | | | | | | | | | | | | | |
| barnacle cypris | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bivalvia sp. A | | | | | | | | | | | | | | | | | | | | | | | | | |
| Boccardiella ligerica | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bugula neritina | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bugula stolonifera | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caprella equilibra | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caprella mutica | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| Caprella sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caprellidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caridea | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaetognatha | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cheilostomate encrusting bryozoa | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chironomidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clytia sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colonial tunicate (Botryliidae?) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conopeum osburni | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P |
| copepods | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corbula sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corophidae sp. (juv.) | | | | | | | | | 1 | | | | | | | | 1 | | | | | 1 | | | |
| crab megalop | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cymothoidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Decapoda | | | | | | | | | | | | | | | | | | | | | | | | | |
| Eteone californica | | | | | | | | | | | | | | | | | | | | | | | | | |
| fish eggs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gammarus daiberi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Garveia franciscana | P | | | | | | | | P | | | | | P | P | P | P | P | | | | | P | | |
| Gastropoda | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gnorimosphaeroma oregonensis/insulare | | | | | | 1 | | | | | | 5 | | | | | | | | | | 1 | | | |
| Grapsidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroid sp. A | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroides elegans | | | | | | | | | | | | | | | | | | | | | | | | | |
| Incisocalliope derzhavini | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jassa carltoni? | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jassa slatteryi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jassa sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jassa staudei | | | | | | | | | | | | | | | | | 3 | | | | | | | | |
| Laticorophium baconi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepas anatifera | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lucifer faxoni | | | | | | | | | | | | | | | | | | | | | | | | | |
| Melita nitida | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monocorophium acherusicum | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monocorophium insidiosum | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monocorophium sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | 5 | 4 | | |
| Mysidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mytilidae (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Neanthes succinea | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemertina | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nudibranchia | | | | | | | | | | | | | | | | | | | | | | | | | |
| Oligochaeta | | | | | | | | | | | | | | | | | | | | | | | | | |
| Polydora cornuta | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | |
| Serpulidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sinelobus stanfordi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Spionidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| sponge-like | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stenothoe sp. | | | | | | | 1 | | | | | | | | | | 3 | | | | | | | | |
| Stenothoidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stylochus franciscanus | | | | | | | | | | | | | 1 | | | | | | | | | 1 | | | |
| Syllidae sp. (juv.) | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| Synidotea laticauda | | 1 | | | | | | | | | 1 | | 6 | | | | | | | 1 | 1 | 17 | 5 | | |
| Tanaidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Turbellaria sp. A | | | | | | | | | | | | | | | | | | | | | | | | | |
| Typosyllis alternata | | | | | | | | | | | | | | | | | | | | | | | | | |
| Uromunna ubiquita | | | | | | | | | | | | 1 | 3 | | | | | | | | | 23 | 3 | | |
| Zeuxo paranormani | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 21 | 1 | P | 1 | P | 4 | 1 | 1 | 1 | P | 2 | 16 | 14 | P | P | P | 8 | P | P | 1 | 1 | 64 | 19 | P | P |

| Species | 2-29 | 2-30 | 2-31 | 2-32 | 2-33 | 2-34 | 2-35 | 2-36 | 2-37 | 2-38 | 2-39 | 2-40 | 2-41 | 2-42 | 2-43 | 2-44 | 2-45 | 2-46 | 2-47 | 2-48 | 2-49 | 3-01 | 3-02 | 3-03 | 3-04 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Algae sp. A | | | | | | | | | | | | | | | | | | | | | | P | | | |
| Algae sp. B | | | | | | | | | | | | | | | | | | | | | | | P | | |
| Allorchestes sp. | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| Americorophium spinicorne | | | | | | | 3 | 1 | | | | 1 | | | | | | | | | | | | | |
| Ampithoe valida | | | | | | | | | | | | | 1 | | | | | | | | | | | | |
| Argulus sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Balanus amphitrite | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Balanus improvisus | 6 | 1 | | | | 23 | 13 | 11 | 1 | 1 | | 8 | 5 | | | | 1 | | 2 | 20 | 19 | 33 | 13 | 12 | 30 |
| Balanus improvisus (dead) | | | | | | | | | | | | | | | | | | | | | | | | | |
| barnacle cypris | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bivalvia sp. A | | | | | | | | | | | | | | | | | | | | | | | | | |
| Boccardiella ligerica | | | | | | | | 2 | | | | | | | | | | | 1 | | | | | | |
| Bugula neritina | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bugula stolonifera | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caprella equilibra | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caprella mutica | | | | | | | | | | | | | | | | | | | | | | | | | |
| Caprella sp. | 2 | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| Caprellidae | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| Caridea | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chaetognatha | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cheilostomate encrusting bryozoa | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chironomidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clytia sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Colonial tunicate (Botryliidae?) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conopeum osburni | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P |
| copepods | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corbula sp. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Corophidae sp. (juv.) | | | 1 | | | | | | | | | | | | | | | | 1 | | | | | | |
| crab megalop | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cymothoidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Decapoda | | | | | | | | | | | | | | | | | | | | | | | | | |
| Eteone californica | | | | | | | | | | | | | | | | | | | | | | | | | |
| fish eggs | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| Gammarus daiberi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Garveia franciscana | | | | | | | | | | | | P | P | | | | | | | | P | | | | |
| Gastropoda | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gnorimosphaeroma oregonensis/insulare | | | | | | 13 | 7 | 3 | | | | | 1 | | | | | | 1 | 1 | 1 | 1 | | | |
| Grapsidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroid sp. A | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroides elegans | | | | | | | | | | | | | | | | | | | | | | | | | |
| Incisocalliope derzhavini | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jassa carltoni? | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jassa slatteryi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jassa sp. (juv.) | | | 1 | | | | | | | | | | 1 | | | | | 1 | | | | | | | |
| Jassa staudei | | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| Laticorophium baconi | | | | | | | | | | | | | | | | | | | | | | | | 1 | |
| Lepas anatifera | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lucifer faxoni | | | | | | | | | | | | | | | | | | | | | | | | | |
| Melita nitida | 1 | | | | | 1 | | | | | 1 | | | | | | | | | | 2 | | | | |
| Monocorophium acherusicum | 12 | | 2 | | | 2 | 2 | 9 | | | | | 8 | | | | | | 8 | | 9 | | | | |
| Monocorophium insidiosum | | | | | | | | 1 | | | | | | | | | | | | | | | | | |
| Monocorophium sp. (juv.) | 4 | 1 | | | | 1 | | 1 | | 1 | | | 4 | 2 | | | | | | 8 | | | | | |
| Mysidae | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mytilidae (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Neanthes succinea | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nemertina | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nudibranchia | | | | | | | | | | | | | | | | | | | | | | | | | |
| Oligochaeta | | | | | | | | | | | | | | | | | | | | | | | | | |
| Polydora cornuta | | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| Serpulidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sinelobus stanfordi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Spionidae sp. (juv.) | 1 | | | | | | | | | | | 1 | 1 | | | | | | | | 1 | | | | |
| sponge-like | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stenothoe sp. | 2 | 3 | | | | | | | | 1 | | | 4 | 1 | | | | | | | 2 | | | | |
| Stenothoidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stylochus franciscanus | 2 | | | | 1 | 1 | 1 | 3 | | | | | | | | | | | | 1 | | | | | |
| Syllidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | 1 | | | | |
| Synidotea laticauda | | | | | 1 | 6 | 2 | 6 | 1 | 1 | | 3 | 2 | 2 | 1 | | | | | 15 | 7 | | | | |
| Tanaidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Turbellaria sp. A | | | 1 | | | | | 1 | | | | | 1 | | | | | | 1 | | | | | | |
| Typosyllis alternata | | | | | | | | | | | | | | | | | | | | | | | | | |
| Uromunna ubiquita | 4 | | | | | 8 | | 2 | | 1 | | 10 | | | | | | | 8 | 1 | 7 | | | | |
| Zeuxo paranormani | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| TOTAL | 34 | 5 | 5 | P | 3 | 55 | 28 | 40 | 2 | 5 | 2 | 23 | 28 | 6 | 1 | P | 1 | 1 | 23 | 46 | 51 | 35 | 13 | 13 | 31 |

| Species | 3-05 | 3-06 | 3-07 | 3-08 | 3-09 | 3-10 | 3-11 | 3-12 | 3-13 | 3-14 | 3-15 | 3-16 | 3-17 | 3-18 | 3-19 | 3-20 | 3-21 | 3-22 | 3-23 | 3-24 | 3-25 | 3-26 | 3-27 | 3-28 | 3-29 | 3-30 | 3-31 | 3-32 | 3-33 | 3-34 | 3-35 | 3-36 | 3-37 | 3-38 | 3-39 | 3-40 | 3-41 | 3-42 | 3-43 | 3-44 | 3-45 | 3-46 | 3-47 | 3-48 | 3-49 | 3-50 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Algae sp. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | P |
| Algae sp. B | | | | | P | P | P | | P | | | | | P | | | | | | | | | | | P | P | | | | | | | | | P | | | | | | | | | | | | P |
| Allorchestes sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Americorophium spinicorne | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 628 |
| Ampithoe valida | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 |
| Argulus sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Balanus amphitrite | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 2 |
| Balanus improvisus | 11 | | | | 4 | 11 | | | | 5 | | | 6 | 1 | | | | | 1 | 9 | 10 | 1 | 8 | 2 | | 5 | 1 | | | 1 | 3 | 1 | | | 10 | | | | | 1 | | | | | | | 16361 |
| Balanus improvisus (dead) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4231 |
| barnacle cypris | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Bivalvia sp. A | 1 | | | | | | 3 | 4 | 1 | | | | 7 | 10 | 1 | | 1 | 25 | 1 | | | | 4 | 2 | | 1 | 5 | 104 | 12 | 8 | | 4 | | | | 1 | | | | | | | | | | 1 | 196 |
| Boccardiella ligerica | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 515 |
| Bugula neritina | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | P |
| Bugula stolonifera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | P |
| Caprella equilibra | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 12 |
| Caprella mutica | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Caprella sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 14 |
| Caprellidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |
| Caridea | | | | | | | | | | | 1 | | | 3 | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 8 |
| Chaetognatha | 15 | 5 | | 1 | 1 | 1 | | | 1 | 3 | 1 | 1 | | 3 | 1 | 4 | 3 | | | 7 | 13 | 1 | 3 | | 1 | 1 | | | 1 | 2 | | | | | | | | | | | | 1 | | | | | 70 |
| Cheilostomate encrusting bryozoa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | P |
| Chironomidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Clytia sp. | | | | | | | | | | | | | | P | | | | | | | | | | | | | P | | | | | | | | | | | | | | | | | | | | P |
| Colonial tunicate (Botryliidae?) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Conopeum osburni | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P | P |
| copepods | 17 | 26 | 2 | | | 2 | 1 | 12 | 7 | 1 | 53 | 12 | | 24 | | | | 65 | 5 | 23 | 115 | 2 | | 8 | 19 | 1 | 6 | | 2 | | 1 | 3 | | | | | | | 3 | 1 | | 3 | | 5 | | 1 | 424 |
| Corbula sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 111 |
| Corophidae sp. (juv.) | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | 529 |
| crab megalop | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | 3 | | | | | 1 | | 1 | | | | | | | | | | | | 6 |
| Cymothoidae | | | | | | | | | | | | | | 4 | | | | 2 | | | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | 8 |
| Decapoda | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Eteone californica | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| fish eggs | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 |
| Gammarus daiberi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 20 |
| Garveia franciscana | | P | | | | | P | P | P | P | | P | P | P | | | | P | P | | | | P | | P | | | P | P | | | | | P | P | P | P | | | | | P | P | P | | | P |
| Gastropoda | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Gnorimosphaeroma oregonensis/insulare | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 3 | | | | | | | | | | | 1 | 1536 |
| Grapsidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | 1 |
| Hydroid sp. A | | | | | | | | | | | | | | | | | | | | | | | | | | | P | | | | | | | | | | | | | | | | | | | | P |
| Hydroides elegans | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Incisocalliope derzhavini | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 511 |
| Jassa carltoni? | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 |
| Jassa slatteryi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 |
| Jassa sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| Jassa staudei | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 20 |
| Laticorophium baconi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Lepas anatifera | 1 | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Lucifer faxoni | | 1 | | | | | | | | | | | | 1 | 2 | 2 | 2 | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | 9 |
| Melita nitida | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 50 |
| Monocorophium acherusicum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 307 |
| Monocorophium insidiosum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Monocorophium sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 234 |
| Mysidae | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 | | | | | | | | | | | | | | | 1 | | | | | | | 3 |
| Mytilidae (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Neanthes succinea | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 |
| Nemertina | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| Nudibranchia | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 35 |
| Oligochaeta | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 37 |
| Polydora cornuta | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 112 |
| Serpulidae sp. (juv.) | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 2 |
| Sinelobus stanfordi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 383 |
| Spionidae sp. (juv.) | 3 | | 2 | | | | | 1 | | | | | | 2 | 1 | | | 2 | | | | | | 1 | | | | 1 | 2 | | | 1 | | | 1 | | 2 | | | | | | | 1 | | | 25 |
| sponge-like | | | | | | 4 | 11 | | 1 | 1 | | 1 | | | | 5 | 3 | 1 | | | | | | | | 1 | | | 7 | 5 | | | | | | 5 | | 2 | 1 | 1 | 3 | 4 | | | | 6 | 90 |
| Stenothoe sp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 59 |
| Stenothoidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| Stylochus franciscanus | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 574 |
| Syllidae sp. (juv.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| Synidotea laticauda | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 10936 |
| Tanaidae sp. (juv.) | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 |
| Turbellaria sp. A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 238 |
| Typosyllis alternata | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 |
| Uromunna ubiquita | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 20617 |
| Zeuxo paranormani | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 18 |
| TOTAL | 49 | 32 | 5 | 1 | 7 | 19 | 15 | 17 | 11 | 10 | 55 | 14 | 13 | 50 | 5 | 12 | 10 | 96 | 7 | 39 | 138 | 5 | 15 | 13 | 21 | 9 | 13 | 110 | 24 | 18 | 5 | 9 | 1 | P | 15 | 6 | 2 | 2 | 4 | 4 | 3 | 8 | P | 6 | 1 | 12 | 59043 |

# APPENDIX B

## SPECIES BIOGEOGRAPHY AND LIFE HISTORY INFORMATION

Table B-1

| Phylum | Class | Species/Taxon Name | Common Name | California Invasion Status | Status in Texas | Geographical Distribution | |
|---|---|---|---|---|---|---|---|
| | | | | | | Native range | Invaded range |
| Crustacea | Copepoda (Calanoida) | Acartia tonsa | calanoid copepod | native | native | Eastern Pacific Ocean, Western Pacific Ocean, Indian Ocean | Caspian Sea, Baltic Sea, European brackish waters |
| Chlorophyta | | Algae sp. A | algae | ? | ? | | |
| Chlorophyta | | Algae sp. B | algae | ? | ? | | |
| Crustacea | Amphipoda | Allorchestes sp. | amphipod | native | no record/not present | Pacific Ocean | |
| Crustacea | Amphipoda | Americorophium spinicorne | amphipod | native | no record/not present | Northeast Pacific | Snake River (Idaho), Pearl Harbor (Hawaii) on hull of USS Missouri |
| Crustacea | Copepoda (Harpacticoida) | Amphiascoides sp. | harpacticoid copepod | native species present | unknown | | |
| Crustacea | Amphipoda | Ampithoe valida | amphipod | introduced | native | Northwest Atlantic, Gulf of Mexico | Northeast Pacific |
| Crustacea | Branchiura | Argulus sp. | fish louse | native species present | native species present | Cosmopolitan | |
| Crustacea | Cirripedia | Balanus amphitrite | Acorn barnacle | introduced | introduced | Indo-West Pacific, but limits of native range are uncertain | North Atlantic, Southwest Atlantic, Western Pacific Ocean, Northeast Pacific (California to Panama) |
| Crustacea | Cirripedia | Balanus improvisus | Bay barnacle | cryptogenic | native | Western Atlantic Ocean | Northeast Atlantic, Caspian Sea, North Pacific Ocean |
| Crustacea | Cirripedia | barnacle cypris | barnacle larval stage | native species present | native species present | | |
| Mollusca | Bivalvia | Bivalvia sp. A | clam | ? | ? | | |
| Annelida | Polychaeta | Boccardiella ligerica | polychaete or bristle worm | introduced | cryptogenic | Northeast Atlantic | Baltic Sea, Northeast Pacific, South Atlantic Ocean, and possibly (cryptogenic range), Northwest Atlantic and Gulf of Mexico |
| Ectoprocta | | Bugula neritina | bryozoan or moss animal | cryptogenic | native | Temperate, subtropical, and tropical waters around the world | Possibly Northeast Pacific above Monterrey Bay: San Francisco Bay, Humboldt Bay, Coos Bay, Friday Harbor |
| Ectoprocta | | Bugula stolonifera | bryozoan or moss animal | introduced | possibly introduced | Northwest Atlantic | Europe, Mediterranean, Panama, Saudi Arabia, possibly Southern California harbors |
| Crustacea | Amphipoda | Caprella equilibra | Skeleton shrimp | native | native | Cosmopolitan | |
| Crustacea | Amphipoda | Caprella mutica | Skeleton shrimp | introduced | no record/not present | Sea of Japan | Europe; USA: Atlantic and Pacific Coasts; New Zealand |
| Crustacea | Amphipoda | Caprella sp. | Skeleton shrimp | native species present | native species present | | |
| Crustacea | Amphipoda | Caprellidae | Skeleton shrimps | native species present | native species present | | |
| Crustacea | Decapoda | Caridea | shrimps | native species present | native species present | | |
| Chaetognatha | | Chaetognatha | arrow worms | native species present | native species present | | |
| Ectoprocta | | Cheilostomate encrusting bryozoan | bryozoan or moss animal | native species present | native species present | | |
| Insecta | Diptera | Chironomidae | midge larva | native species present | native species present | | |
| Cnidaria | Hydrozoa | Clytia sp. | hydroid | cryptogenic | native species present | Worldwide range in temperate waters | Range possibly extended by shipping |
| Chordata | Ascidiacea | Colonial tunicate (Botryllidae?) | sea squirts | native species present | native species present | Worldwide range in temperate waters | At least three species of botryllids are considered to be introduced in San Francisco Bay. Range of many species possibly extended by shipping and oysters |
| Ectoprocta | | Conopeum osburni | bryozoan or moss animal | cryptogenic | no record/not present | Coastal waters off Santa Barbara, CA | Newly described species in a taxonomically difficult genus. Some species of Conopeum have been introduced to San Francisco Bay and others have been reported as invasive in different parts of the world. |
| Mollusca | Bivalvia | Corbula sp. | clam | native species present | native species present | | The most likely species, Corbula amurensis, is invasive in San Francisco Bay. |
| Crustacea | Amphipoda | Corophidae sp. (juv.) | amphipod | native species present | native species present | | |
| Crustacea | Decapoda | crab megalop | juvenile crab | native species present | native species present | | |
| Crustacea | Isopoda | Cymothoidae | isopods | native species present | native species present | | |
| Crustacea | | Decapoda | shrimps and crabs | native species present | native species present | | |
| Crustacea | Copepoda (Harpacticoida) | Diarthrodes sp. | harpacticoid copepod | native species present | unknown | | |
| Annelida | Polychaeta | Eteone californica | polychaete or bristle worm | cryptogenic | no record/not present | Northeast Pacific | Possibly introduced with Atlantic oysters into San Francisco Bay |
| Chordata | Osteichthyes | fish eggs | | native species present | native species present | | |
| Crustacea | Amphipoda | Gammarus daiberi | amphipod | introduced | no record/not present | Northwest Atlantic | San Francisco Bay, CA. |
| Cnidaria | Hydrozoa | Garveia franciscana | hydroid | introduced | introduced | Unknown, possibly Indian Ocean | Northwest Atlantic, Northeast Atlantic, Southwest Atlantic, Gulf of Mexico, Northeast Pacific, Southwest Pacific, Black Sea, Caspian Sea |
| Mollusca | | Gastropoda | marine snails | native species present | native species present | | |
| Crustacea | Isopoda | Gnorimosphaeroma insulare | pillbug | native | no record/not present | Northeast Pacific | |
| Crustacea | Isopoda | Gnorimosphaeroma oregonensis | Oregon pillbug | native | no record/not present | North Pacific Ocean | |
| Crustacea | Decapoda | Grapsidae | rock, shore, and marsh crabs | native species present | native species present | | |
| Crustacea | Copepoda (Cyclopoda) | Halicyclops sp. | cyclopoid copepod | native species present | unknown | | |
| Cnidaria | Hydrozoa | Hydroid sp. A | hydroid | ? | ? | | |
| Annelida | Polychaeta | Hydroides elegans | tubeworm | introduced | introduced | Indo-Pacific | Northeast Atlantic, Florida, Gulf of Mexico, Northeast Pacific |
| Crustacea | Amphipoda | Incisocalliope derzhavini | amphipod | introduced | no record/not present | West Pacific Ocean | San Francisco Bay, CA, to Yaquina Bay, OR |
| Crustacea | Amphipoda | Jassa carltoni | amphipod | native | no record/not present | Northeast Pacific | |
| Crustacea | Amphipoda | Jassa slatteryi | amphipod | cryptogenic | no record/not present | Pacific and Atlantic oceans, Mediterranean Sea | |
| Crustacea | Amphipoda | Jassa sp. (juv.) | amphipod | native species present | native species present | | |

Table B-2

| Phylum | Class | Species/Taxon Name | Common Name | California Invasion Status | Status in Texas | Geographical Distribution | |
|---|---|---|---|---|---|---|---|
| | | | | | | Native range | Invaded range |
| Crustacea | Amphipoda | Jassa staudei | amphipod | native | no record/not present | Northeast Pacific | |
| Crustacea | Amphipoda | Jassa staudei | amphipod | native | no record/not present | Northeast Pacific | |
| Crustacea | Amphipoda | Laticorophium baconi | amphipod | cryptogenic | introduced | Possibly native to Northeast Pacific and Peru | Hawaii, Northwest Pacific, Southwest Pacific, Florida, and Gulf of Mexico |
| Crustacea | Cirripedia | Lepas anatifera | Pelagic gooseneck barnacle | native | native | Cosmopolitan in tropical and temperate oceans (pelagic) | |
| Crustacea | Decapoda | Lucifer faxoni | shrimp | no record/not present | native | Warm waters of the Atlantic Ocean; Caribbean, Gulf of Mexico | |
| Crustacea | Amphipoda | Melita nitida | amphipod | introduced | native | Northwest Atlantic, Caribbean, Gulf of Mexico | Northeast Pacific, Northeast Atlantic |
| Crustacea | Copepoda (Harpacticoida) | Mesochra sp. | harpacticoid copepod | native species present | unknown | | |
| Crustacea | Amphipoda | Monocorophium acherusicum | amphipod | introduced | introduced | Unknown, possibly Northeast Atlantic where it was originally described | Northwest Atlantic, Gulf of Mexico, Brazil, Northeast Pacific, Northwest Pacific, Hawaii, Southwest Pacific, Indian Ocean |
| Crustacea | Amphipoda | Monocorophium insidiosum | amphipod | introduced | possibly introduced | North Atlantic Ocean | North Pacific Ocean, Chile, Hawaii |
| Crustacea | Amphipoda | Monocorophium sp. (juv., one of the above) | amphipod | introduced | introduced | | |
| Crustacea | Mysidacea | Mysidae | mysid or fairy shrimps | native species present | native species present | | |
| Mollusca | Bivalvia | Mytilidae (juv.) | mussel | native species present | native species present | | |
| Annelida | Polychaeta | Neanthes succinea | pile worm | introduced | native | Atlantic Ocean, Gulf of Mexico | Northeast Pacific, Southwest Pacific |
| Nemertina | | Nemertina | ribbon worms | native species present | native species present | | |
| Crustacea | Copepoda (Harpacticoida) | Nitokra sp. | harpacticoid copepod | native species present | unknown | | |
| Mollusca | Gastropoda | Nudibranchia (juv.) | sea slugs | native species present | native species present | | |
| Crustacea | Copepoda (Cyclopoda) | Oithona sp. | cyclopoid copepod | native species present | native species present | | |
| Annelida | Oligochaeta | Oligochaeta | oligochaete worms | native species present | native species present | | |
| Annelida | Polychaeta | Polydora cornuta | mud worm | cryptogenic | native | North Atlantic Ocean, Gulf of Mexico | possibly Northeast Pacific |
| Crustacea | Copepoda (Harpacticoida) | Schizopera sp. | harpacticoid copepod | native species present | unknown | | |
| Annelida | Polychaeta | Serpulidae sp. (juv.) | plume worms | native species present | native species present | | |
| Crustacea | Tanaidacea | Sinelobus stanfordi | tanaid | introduced | no record/not present | Unknown, cited for the Pacific Ocean, Northwest Atlantic, Caribbean, Gulf of Mexico (but not Texas), Southwest Atlantic and Southeast Atlantic | possibly Northeast Pacific, Southwest Pacific |
| Annelida | Polychaeta | Spionidae sp. (juv.) | polychaete or bristle worms | native species present | native species present | | |
| Crustacea | Amphipoda | Stenothoe sp. | amphipod | native species present | native species present | The most likely species, Stenothoe valida, is cosmopolitan in tropical and temperate oceans (including the Gulf of Mexico), but its native range is unknown | Stenothoe valida is considered a recent introduction to the Northeast Pacific |
| Crustacea | Amphipoda | Stenothoidae sp. (juv.) | amphipod | native species present | native species present | | |
| Platyhelminthes | Turbellaria | Stylochus franciscanus | flatworm | native | no record/not present | Coast of California | |
| Annelida | Polychaeta | Syllidae sp. (juv.) | polychaete or bristle worm | native species present | native species present | | |
| Crustacea | Isopoda | Synidotea laticauda | isopod | introduced | no record/not present | Northwest Pacific | Northeast Pacific (SF Bay, California Coast, Willapa Bay), Southwest Pacific, North Atlantic Ocean (Europe, US Mid-Atlantic States) |
| Crustacea | Tanaidacea | Tanaidae sp. (juv.) | tanaid | native species present | native species present | | |
| Platyhelminthes | Turbellaria | Turbellaria sp. A | flatworm | ? | ? | | |
| Annelida | Polychaeta | Typosyllis alternata | polychaete or bristle worms | cryptogenic | cryptogenic | Unknown, cited for Arctic Ocean, North Pacific Ocean, Southwest Pacific, North Atlantic Ocean, Mediterranean Sea, and Black Sea | Unknown |
| Crustacea | Ostracoda | unidentified ostracod | ostracod | native species present | native species present | | |
| | | unidentified sponge-like organism | | ? | ? | | |
| Crustacea | Isopoda | Uromunna ubiquita | isopod | native | no record/not present | Northeast Pacific | |
| Crustacea | Tanaidacea | Zeuxo paranormani | tanaid | native | no record/not present | Coast of California | |
| | | | | | | | |

Table B-3

| Phylum | Class | Species/Taxon Name | Salinity (psu) | | Temperature (ºC) | | Substrate Preference-adults | Developmental mode | Feeding mode | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Range | Optimum | Range | Optimum | | | | |
| Crustacea | Copepoda (Calanoida) | Acartia tonsa | brackish to salt | | | | planktonic | eggs released, planktonic larvae | omnivore, suspension feeder | |
| Chlorophyta | | Algae sp. A | | | | | | | | |
| Chlorophyta | | Algae sp. B | | | | | | | | |
| Crustacea | Amphipoda | Allorchestes sp. | | | | | epibiont | brooder | | Hendrycks and Bousfield 2001 |
| Crustacea | Amphipoda | Americorophium spinicorne | tidal fresh, brackish | 0-7 reprod. range | | 8-23 | epibenthic tube dweller | brooder | interface feeder | Davidson et al. 2006 |
| Crustacea | Copepoda (Harpacticoida) | Amphiascoides sp. | brackish to salt | | | | infaunal, epibiont | | herbivore, detritus feeder, suspension feeder | |
| Crustacea | Amphipoda | Ampithoe valida | | | | | epibenthic tube dweller | brooder | | Cohen et al. 2002, Cohen and Carlton 1995 |
| Crustacea | Branchiura | Argulus sp. | | | | | parasitic | | | |
| Crustacea | Cirripedia | Balanus amphitrite | 10-52 | 20-40 | 1.5-40 | 10-30 | epibenthic | planktonic larvae | suspension feeder | Davidson et al. 2007 |
| Crustacea | Cirripedia | Balanus improvisus | 0-? | 5-25 | -2-38 | 14-30 | epibenthic | planktonic larvae | suspension feeder | Davidson et al. 2006 |
| Crustacea | Cirripedia | barnacle cypris | | | | | | | | |
| Mollusca | Bivalvia | Bivalvia sp. A | | | | | | | | |
| Annelida | Polychaeta | Boccardiella ligerica | 0-30 | 2-20 | | | infaunal | demersal eggs laid in strings in burrows, planktonic larvae | interface feeder | Davidson et al. 2006 |
| Ectoprocta | | Bugula neritina | | | | | epibenthic | planktonic larvae | suspension feeder | Cohen and Carlton 1995 |
| Ectoprocta | | Bugula stolonifera | | | | | epibenthic | planktonic larvae | suspension feeder | Cohen and Carlton 1995 |
| Crustacea | Amphipoda | Caprella equilibra | | | | | epibiont | brooder | carnivore/omnivore | McCain 1968 |
| Crustacea | Amphipoda | Caprella mutica | 15-35 | | -1.8-25 | | epibiont | brooder | carnivore/omnivore | Ashton 2006, CA Fish & Game 2002 |
| Crustacea | Amphipoda | Caprella sp. | | | | | epibiont | brooder | carnivore/omnivore | |
| Crustacea | Amphipoda | Caprellidae | | | | | | | | |
| Crustacea | Decapoda | Caridea | | | | | | | | |
| Chaetognatha | | Chaetognatha | | | | | | | | |
| Ectoprocta | | Cheilostomate encrusting bryozoan | | | | | | | | |
| Insecta | Diptera | Chironomidae | | | | | | | | |
| Cnidaria | Hydrozoa | Clytia sp. | | | | | epibenthic | asexual reproduction and planktonic medusa | carnivore | Davidson et al. 2007, Cohen and Carlton 1995 |
| Chordata | Ascidiacea | Colonial tunicate (Botryliidae?) | | | | | epibenthic | | suspension feeder | Cohen and Carlton 1995 |
| Ectoprocta | | Conopeum osburni | | | | | epibenthic | brooder, planktonic larvae (inferred) | suspension feeder | Soule et al. 1995 as cited in Davidson et al. 2006 |
| Mollusca | Bivalvia | Corbula sp. | | | | | infaunal | planktonic larvae | suspension feeder | |
| Crustacea | Amphipoda | Corophidae sp. (juv.) | | | | | | | | |
| Crustacea | Decapoda | crab megalop | | | | | | | | |
| Crustacea | Isopoda | Cymothoidae | | | | | | | | |
| Crustacea | | Decapoda | | | | | | | | |
| Crustacea | Copepoda (Harpacticoida) | Diarthrodes sp. | brackish to salt | | | | infaunal, epibiont | | herbivore, detritus feeder, suspension feeder | |
| Annelida | Polychaeta | Eteone californica | | | | | | | | CA Fish & Game 2002, Carlton 1979 |
| Chordata | Osteichthyes | fish eggs | | | | | | | | |
| Crustacea | Amphipoda | Gammarus daiberi | 1-15 | 1-5 | ?-32 | | epibenthic, pelagic | brooder | herbivore, detritus feeder, omnivore | Davidson et al. 2006, Cohen and Carlton 1995 |
| Cnidaria | Hydrozoa | Garveia franciscana | 1-35 | 5-25 | 0-35 | 10-32 | epibenthic | brooder, planktonic larvae | suspension feeder | Davidson et al. 2007, Cohen and Carlton 1995 |
| Mollusca | | Gastropoda | | | | | | | | |
| Crustacea | Isopoda | Gnorimosphaeroma insulare | fresh to brackish | 0-2 | | | epibenthic | brooder | herbivore, detritus feeder | Davidson et al. 2006 |
| Crustacea | Isopoda | Gnorimosphaeroma oregonensis | brackish to salt | | | | epibenthic | brooder | herbivore, detritus feeder | Davidson et al. 2006 |
| Crustacea | Decapoda | Grapsidae | | | | | | | | |
| Crustacea | Copepoda (Cyclopoda) | Halicyclops sp. | brackish to salt | | | | epibenthic and planktonic | | herbivore, detritus feeder, suspension feeder | |
| Cnidaria | Hydrozoa | Hydroid sp. A | | | | | epibenthic | | | |
| Annelida | Polychaeta | Hydroides elegans | 15-42 | | 13-30 | | epibenthic | planktonic larvae | suspension feeder | Smithsonian Marine Station, Fort Pierce, database: www.sms.si.edu |
| Crustacea | Amphipoda | Incisocalliope derzhavini | 6-32 | | | | epibenthic | | | Cohen and Carlton 1995 |
| Crustacea | Amphipoda | Jassa carltoni | | | | | epibenthic tube-building | | | Conlan 1990 |
| Crustacea | Amphipoda | Jassa slatteryi | | | | | epibenthic tube-building | | | Conlan 1990, Maloney et al. 2006 |
| Crustacea | Amphipoda | Jassa sp. (juv.) | | | | | epibenthic tube-building | | | Conlan 1990 |
| Crustacea | Amphipoda | Jassa staudei | | | | | epibenthic tube-building | | | Conlan 1990, Maloney et al. 2006 |
| Crustacea | Amphipoda | Laticorophium baconi | ?-39 | polyhaline to euhaline | | | epibenthic | brooder | herbivore, detritus feeder, suspension feeder | Davidson et al. 2007, LeCroy 2004 |
| Crustacea | Cirripedia | Lepas anatifera | | | | 19-25 | epibenthic, epibiont | planktonic larvae | suspension feeder | |
| Crustacea | Decapoda | Lucifer faxoni | | | | | planktonic | | | Williams 1984 |
| Crustacea | Amphipoda | Melita nitida | 0-30 | 3-20 | | | epibiont | brooder | herbivore, detritus feeder, omnivore | Davidson et al. 2006, Cohen and Carlton 1995 |
| Crustacea | Copepoda (Harpacticoida) | Mesochra sp. | brackish to salt | | | | infaunal, epibiont | | herbivore, detritus feeder, suspension feeder | |

Table B-4

| Phylum | Class | Species/Taxon Name | Salinity (psu) | | Temperature (°C) | | Substrate Preference-adults | Developmental mode | Feeding mode | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Range | Optimum | Range | Optimum | | | | |
| Crustacea | Amphipoda | Monocorophium acherusicum | 0-38 | | -2 -30 | 10-30 | epibenthic tube-building | brooder | herbivore, detritus feeder, suspension feeder | Davidson et al. 2007, Cohen and Carlton 1995, LeCroy 2004 |
| Crustacea | Amphipoda | Monocorophium insidiosum | 0-33 | <18 | | | epibenthic tube-building | brooder | | Cohen and Carlton 1995, LeCroy 2004 |
| Crustacea | Amphipoda | Monocorophium sp. (juv., one of the above) | | | | | epibenthic tube-building | brooder | | CA Fish & Game 2002 |
| Crustacea | Mysidacea | Mysidae | | | | | epibenthic and planktonic | | | |
| Mollusca | Bivalvia | Mytilidae (juv.) | | | | | epibenthic | | | |
| Annelida | Polychaeta | Neanthes succinea | 2.5-65 | | -2-34 | | Infaunal and epibenthic | planktonic eggs, planktonic larvae | carnivore, detritus feeder, omnivore | Davidson et al. 2006, Cohen and Carlton 1995 |
| Nemertina | | Nemertina | | | | | | | | |
| Crustacea | Copepoda (Harpacticoida) | Nitokra sp. | brackish to salt | | | | infaunal, epibiont | | herbivore, detritus feeder, suspension feeder | |
| Mollusca | Gastropoda | Nudibranchia (juv.) | | | | | | | | |
| Crustacea | Copepoda (Cyclopoda) | Oithona sp. | brackish to salt | | | | planktonic | | herbivore, suspension feeder | |
| Annelida | Oligochaeta | Oligochaeta | | | | | | | | |
| Annelida | Polychaeta | Polydora cornuta | | | | | epibenthic | | | Cohen and Carlton 1995 (as Polydora ligni) |
| Crustacea | Copepoda (Harpacticoida) | Schizopera sp. | brackish to salt | | | | infaunal, epibiont | | herbivore, detritus feeder, suspension feeder | |
| Annelida | Polychaeta | Serpulidae sp. (juv.) | | | | | | | | |
| Crustacea | Tanaidacea | Sinelobus stanfordi | 0-45+ | 0.5-30 | | | epibenthic | brooder | suspension feeder, detritus feeder | Davidson et al. 2007, Cohen and Carlton 1995 |
| Annelida | Polychaeta | Spionidae sp. (juv.) | | | | | | | | |
| Crustacea | Amphipoda | Stenothoe sp. | | | | | epibiont, commensal | brooder | carnivore, detritus feeder, omnivore | Davidson et al. 2007, Cohen and Carlton 1995 |
| Crustacea | Amphipoda | Stenothoidae sp. (juv.) | | | | | | | | |
| Platyhelminthes | Turbellaria | Stylochus franciscanus | | | | | epibenthic | | | Hyman 1953 |
| Annelida | Polychaeta | Syllidae sp. (juv.) | | | | | | | | |
| Crustacea | Isopoda | Synidotea laticauda | | | | | | | | Bushek and Boyd 2006, Cohen and Carlton 1995, Chapman and Carlton 1994 |
| Crustacea | Tanaidacea | Tanaidae sp. (juv.) | | | | | | | | |
| Platyhelminthes | Turbellaria | Turbellaria sp. A | | | | | epibenthic | | | |
| Annelida | Polychaeta | Typosyllis alternata | up to 35 | | | | epibenthic, epibiont | planktonic eggs, planktonic larvae | | Davidson et al. 2006 |
| Crustacea | Ostracoda | unidentified ostracod | | | | | | | herbivore, detritus feeder, suspension feeder | |
| | | unidentified sponge-like organism | | | | | | | | |
| Crustacea | Isopoda | Uromunna ubiquita | | | | | epibenthic | brooder | | CA Fish & Game 2002, Appendix A |
| Crustacea | Tanaidacea | Zeuxo paranormani | | | | | epibenthic | brooder | | CA Fish & Game 2002, Appendix A; Sieg and Winn 1981 |